53. *New York Times*, December 30, 1969, p. 14; January 4, 1970, p. 29; February 2, 1970, p. 27.
54. *New York Times*, June 18, 1970, p. 35.
55. *Time*, April 12, 1971, p. 45; *New York Times*, May 14, 1970, p. 6.
56. Robert Gillette, "DDT: Its Days are Numbered, Except Perhaps in Pepper Fields," *Science* 176 (1972): 1313.
57. *EDF et. al* v. *EPA etc.*, D.C. Cir. Op. 72-1548 etc. (6 suits), December 18, 1973.
58. "Decreasing Use of Organochlorines is Result of Insect Resistance, New Chemicals," *Chemical and Engineering News*, August 9, 1971, p. 17.
59. Quoted in the *New York Times*, November 21, 1971, Section IV, p. 13.
60. *Ibid.*
61. *Ibid.*
62. Gillette, "DDT: Its Days Are Numbered," p. 1314.
63. See, for example, Charles F. Wurster, "Aldrin and Dieldrin," *Environment*, October 1971, p. 33.
64. In 1969 there were 900 pesticidal chemicals registered for use in the United States. See, e.g., the *Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health*, p. 46.

CHAPTER 11

Matthew Meselson and the United States Policy on Chemical and Biological Warfare

Matthew Meselson is a slight, soft-spoken professor of biochemistry at Harvard who often seems to be occupying the calm at the center of a hurricane of activity. The scene which greeted one of the authors on an afternoon visit to his laboratory during the spring of 1973 was typical: Meselson's graduate students had congregated for wine, cheese, discussion, and laughter in a room next to his office. One door farther down his secretary—long-haired, bearded, and very efficient—was typing. And Meselson himself was working at a table in his office with a student, Robert Baughman, putting the final touches on a paper between telephone interruptions. Meselson apologized sincerely for the fact that he was still finishing up and invited the visitor to look around the office for a few minutes.

The office had the usual academic complement of bookshelves, but their contents were not restricted to books and journals relating to Meselson's professional interests in molecular biology: there were also loose-leaf binders of press clippings, Congressional hearings, reports, and other material on his second great concern of recent years—chemical and biological warfare (CBW). Around the office there was also considerable evidence of Meselson's effort to pull together the final report of the Herbicide Assessment Commission (HAC) sponsored by the 120,000 member American Association for the Advancement of Science. Meselson had led the HAC on a fact-finding trip to South Vietnam in the summer of 1970.

On the easel in the corner stood a topographic map of South Vietnam overlaid with several transparent plastic sheets. Meselson got up to explain that each sheet corresponded to a particular year and that the thin lines on each sheet showed the defoliation and crop-destruction missions flown that year. One's attention was caught by one large mountain valley, perhaps fifteen miles long, covered by many lines. Meselson explained that the valley was customarily blanketed by antipersonnel bombs just before the slow-flying spray planes flew over on a crop-destruction mission. Although U.S. Army officials had originally told the HAC that the valley was unpopulated, Meselson later identified many dwellings on aerial photographs of the area.[1] More recently Meselson had obtained the Army's official figures indicating a civilian population of 17,000 Montagnard tribesmen in the valley.

On several shelves lay stacks of color photographs which Meselson had taken during the HAC visit to South Vietnam. There were pictures of the primitive Montagnard people, many of the women bare-breasted; pictures of a mangrove forest which had been sprayed with herbicides years before—all that was left now was a mass of small barkless tree trunks jutting crookedly out of the bare earth, a grey wasteland; and then there was an aerial photograph of the rich bright green of a living mangrove forest with the dark channels of a river delta winding through it. In December 1970, a few days before the HAC publicly released its preliminary report accompanied by these photographs (but after they had given the White House a preview) the Nixon administration had announced that the herbicide-spraying operations in South Vietnam would be phased out. But by this time almost 10 percent of the area of South Vietnam had been sprayed.

The work which Meselson and his student, Baughman, were now writing up had been stimulated by a problem that had confronted the HAC almost three years before. Meselson and others were concerned about the levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin (abbreviated TCDD or simply called "dioxin") that may have accumulated in the South Vietnamese food supply. Dioxin, which occurs as a contaminant of the herbicide-defoliant 2,4,5-T (discussed in Chapter 6) is extraordinarily poisonous: it is lethal to guinea pigs at doses of 0.6 parts per billion (10^{-9}) of body weight, and it causes birth defects at even smaller concentrations. (The lethal dose for a rat is fifty times higher, that for man is unknown.) What makes dioxin even more dangerous is the fact that it is chemically relatively stable in the environment and that it tends like DDT to accumulate in fatty tissue. As a result, the effects of small doses of dioxin can be cumulative, and it can concentrate in the food chain—and ultimately in man.

In 1970 standard chemical techniques could detect dioxin in food only in concentrations exceeding ten parts per billion—more than ten times the *lethal* concentration for guinea pigs. Since neither the government agencies responsible for regulating pesticides nor the manufacturers of 2,4,5-T seemed particularly interested in improving these techniques, Meselson and Baughman undertook the task. Now, two years later, they had developed a technique which was about

10,000 times more sensitive than the previous methods used (i.e., capable of detecting one part dioxin per trillion by weight). In their first tests on fish samples that the HAC had brought back frozen from South Vietnam, they found dioxin up to concentrations of 0.8 parts per billion. These findings have caused considerable concern and, at the time of this writing, measurements were being rushed on other samples from Vietnam and elsewhere including the United States where 2,4,5-T is used in popular weed and brush killers.[2]

The development of the dioxinmeasurement technique and even the existence of the HAC itself represent only the most recent episodes in Professor Meselson's long involvement with chemical and biological warfare. That involvement began only a few years after Meselson had become a professional scientist, and it has continued for more than a decade.

The Arms Control and Disarmament Agency

Starting in 1957, his first year out of graduate school, Meselson participated in a series of fundamental experiments on the replication of DNA (deoxyribonucleic acid), the molecule which stores and transmits an individual's genetic "code." In 1960 he was appointed associate professor of biology at Harvard, and four years later he was promoted to full professor. Like a number of other promising young scientists, Meselson was introduced to government advising rather early. Several of his older scientific colleagues were already high-level scientific advisors, and in 1963 one of them, Professor Paul Doty of Harvard's chemistry department, then a member of the President's Science Advisory Committee (PSAC), interested Meselson in consulting for the U.S. Arms Control and Disarmament Agency (ACDA). (The ACDA had been established by President Kennedy to prepare for negotiations on the atmospheric nuclear test-ban treaty of 1963.)

Meselson agreed to spend the summer of 1963 at the ACDA and was assigned to study European nuclear defense problems. He soon realized, however, that he could not hope to contribute much of importance on this tangled subject in a summer's time, so he arranged to study chemical and biological warfare (CBW) instead. It was a subject for which his biological background better suited him, and furthermore one which neither the ACDA nor, as it turned out, any other civilian agency had yet subjected to serious review. The State Department, the Defense Department, and the Central Intelligence Agency all offered Meselson excellent cooperation in his summer study, allowing him access to a great deal of secret information. The Army even conducted Meselson and a Harvard colleague, J. D. Watson, on a tour of its chief biological warfare research center, Fort Detrick in Maryland.[3] (Watson, famous as the codiscoverer of the double-helical structure of DNA, was serving at this time on a PSAC panel studying the technical aspects of CBW.)

American CBW Policy

What Meselson learned profoundly disturbed him. Civilian officials and the top military leadership had repeatedly yielded to constant pressure from the CBW technologists. A series of policy changes, each one relatively minor, had moved America further and further away from its traditional position—which had been unequivocally articulated by President Franklin Roosevelt in 1943, at a time when his generals were considering the use of chemical warfare against the Japanese:

> Use of such weapons has been outlawed by the general opinion of civilized mankind. This country has not used them.... I state categorically that we shall under no circumstances resort to the use of such weapons unless they are first used by our enemies.[4]

By 1956 a new United States CBW policy had begun to emerge. In that year's edition of the U.S. Army field manual, *The Law of Land Warfare*, the traditional provision that "gas warfare and bacteriological warfare are employed by the United States against enemy personnel only in retaliation for their use by an enemy" [5] was replaced by the following statement:

> The United States is not a party to any treaty, now in force, that prohibits or restricts the use in warfare of toxic or nontoxic gases, or smoke or incendiary materials or of bacteriological warfare.[6]

By 1959, the Army CBW establishment had become so bold as to launch a propaganda campaign featuring speeches by Chemical Corps generals (often under the sponsorship of the American Chemical Society) and pro-CBW newspaper and magazine articles, including one in *Harper's* by Brigadier General J. H. Rothschild, commanding general of the (since-reorganized) Chemical Corps Research and Development Command.[7] The purpose of this campaign was twofold: to obtain public and Congressional support for more funding for CBW research and weapons procurement, and to soften public antipathy toward CBW use in combat. It appears to have succeeded at least in the former objective: during the Kennedy administration, spending for CBW increased more than threefold, reaching $300 million per year by 1964. CBW weaponry was now procured on a massive scale and extensively incorporated into Army training.[8]

Even more ominously, in 1961 the Kennedy administration had given the go-ahead to the use of herbicides for defoliating the jungle and destroying crops in "enemy areas" of South Vietnam. Although poisonous gases were not being used, a firebreak had been crossed—the United States was waging chemical warfare. In 1962, during the Cuban missile crisis, an attack on Cuba with an "incapacitating" biological weapon was seriously considered by military officials as part of a U.S. invasion plan. According to Representative Richard D. McCarthy (D.-N.Y.), the plan advanced to the point where Venezuelan equine encephalomyelitis germ warfare agents were placed aboard planes in preparation for use. Although this agent is not officially classified as "lethal," it has been

estimated that more than 1 percent of the exposed population would have died as a result of such an attack.[9]

The tremendous American effort to develop such biological ("germ") weapons was particularly disturbing to Meselson. What he had learned about these weapons during his summer at the Arms Control and Disarmament Agency convinced him that they were undesirable on almost every count. At the most fundamental level, he later asked:

> What consideration can be given to moral factors in the conduct of war—society's least moral activity? Widespread restraints against certain forms of human combat may be partly based on instinct and accordingly may be wiser than we know.... In the course of [the development of increasingly more powerful weapons], governments and people have come to countenance ever increasing levels of destruction in the pursuit of national objectives. At some point this process must be arrested and then reversed if civilization is to overcome the threat to its existence posed by the application of science to warfare.... It would be a backwards step to extend the varieties of violence which we now tolerate to include such hitherto reviled means as chemical and biological warfare.[10]

Meselson has also cited many "practical" objections to biological warfare. Thus, although biological weapons might be cheap, might be most suitable for attacking large populations, and might be most effective in a sudden, surprise attack, these are all characteristics that the United States should *not* desire in weaponry. Since the United States already has an enormous arsenal of nuclear weapons, why encourage developments which would make weapons of mass destruction easily available to the smaller nations or to terrorist groups? Moreover, biological weapons would be largely ineffective as battlefield weapons inasmuch as the disease microorganisms require incubation periods in victims of one or more days before taking effect.

Insofar as deterrence is effective, the use of biological warfare by an enemy against United States armed forces should be deterred by the threat of weapons already in existence. Another argument, that the United States has to proceed with the development of CBW weapons in order to be able to develop defenses against them is unconvincing because it would be impossible to prepare, let alone administer, inoculations or other defenses against all the germs which an enemy might employ in warfare. The best general defense against chemical as well as biological attack would be a respiratory face mask, air conditioning, and, in extreme cases, protective suits—devices that would prevent poisons or microbes from coming in contact with their human targets. And the development of such defenses does not require the development of germ weapons themselves.

Meselson wrote a report for the ACDA which was sharply critical of the developing American CBW policy. But the report seems to have been "filed away someplace and probably forgotten," although it may have encouraged the ACDA to undertake the modest series of studies in CBW disarmament which they began in 1964. Meselson thinks that the extensive use of secret information in his

report, which he had hoped would give it added authority, may have instead weakened its impact by decreasing its circulation.

Making CBW a Public Issue

Another science advisor might have let it go at that: report submitted, filed, and forgotten. Meselson did not. Since 1963, Meselson estimates, he has spent at least a quarter of his time on anti-CBW activities, increasing to half in the period from 1969 through 1971. At first, he worked mainly as a continuing consultant to the ACDA and also through the international "Pugwash" meetings of scientists interested in disarmament.[11] He was very concerned during this period lest efforts to publicize American CBW activities have the effect of further interesting foreign nations in CBW, which would in turn greatly increase the difficulty of CBW disarmament. But while he was initially worried about publicizing the United States CBW effort in the process of criticizing it, by 1966 Meselson had changed his mind. By this time the U.S. program of forest defoliation, crop destruction, and battlefield use of tear gas in South Vietnam had become truly massive.[12] And as Meselson later explained:

> of all the countries in the world, it is the United States which conspicuously pioneers in this area, whose officers and officials consistently have been saying—at lower levels than the President—that these are the weapons of the future. It's the United States which has had conspicuous and major budgetary increases. And it's the United States which has refrained from giving international assurances that it would not be the first to use these weapons.[13]

Meselson therefore decided to join with John Edsall at Harvard in circulating a petition within the scientific community calling for a comprehensive top-level goverment review of the United States' CBW policy. The petition also called for an end to the use of chemical antipersonnel and anticrop weapons in Vietnam and for the reestablishment of the traditional policy forbidding American initiation of the use of CBW.

The job of circulating the petition and collecting signatures was handled primarily by Meselson and a younger biochemist, Milton Leitenberg. They began by sending it to a number of prominent American scientists whose views lay in the center of the political spectrum, reasoning that once the petition had received the endorsement of moderates, more liberal scientists would hasten to add their support. A preliminary petition was released to the press in September 1966 with the signatures of twenty-two leading scientists, including seven Nobel Prize winners.[14] The attendant publicity and the help of the Federation of American Scientists, which sent letters to its entire membership of 2,500, enabled the sponsors to collect the signatures of some 5,000 scientists by the time the petition was presented to the White House on February 14, 1967.[15]

President Johnson's response to the petition is not recorded. He seems to have ignored it. The Pentagon somewhat later began a review of its CBW policies, but that was scuttled.

The petition did contribute to the growth in the public consciousness of CBW as an issue, however. Around 1967 magazine and newspaper articles began appearing which were both well informed and highly critical of current American CBW policy. These were followed by several books. Seymour Hersh's *Chemical and Biological Warfare: America's Hidden Arsenal*, published in spring 1968, was particularly forceful and well documented and succeeded in raising a considerable furor.[16] Meanwhile, in its own inimitable way, the Army committed a massive blunder that focused more attention on the pernicious possibilities of CBW than the anti-CBW scientists could ever have hoped to arouse by themselves.

On March 13, 1968, a cloud of the lethal, highly persistent nerve gas VX from a test spraying accidentally drifted off from the Army's CBW Dugway Proving Ground in western Utah. Within three days, over 6,000 sheep that had been grazing as far away as forty-five miles from the test location were dead. At first the Army refused to admit that they had even been carrying out tests. As the facts became clearer, however, the Army was forced to admit bit by bit, over a period of fourteen months, that its nerve gas had killed the sheep; and it eventually paid damage claims totaling nearly a million dollars. Finally, having been compelled by an aroused Congressional subcommittee "to tell the truth, the whole truth, and nothing but the truth," Army spokesmen reluctantly ended their denials.[17]

The Nixon Administration Review

By February 1969, just after President Nixon had taken office, the United States' CBW program had become so controversial that both the CBS and NBC television networks screened documentary programs on the issue.[18] Neither Nixon nor the Republican party was identified with the CBW expansion which had occurred during the Kennedy-Johnson administration, so the Nixon administration had the opportunity of reexamining the issues on their merits. CBW opponents renewed their efforts to obtain a thorough high-level policy review. Through Presidential assistant Henry Kissinger, who had been his neighbor in Cambridge, Meselson now had a special avenue of access to the President.

At the same time, Congress was beginning to take an interest in CBW. Meselson received an invitation from the Senate Foreign Relations Committee to "educate" it—as the chairman, Senator J. William Fulbright, put it—on the subject. The Committee met for this purpose on April 30, 1969, in executive (i.e., closed) session. A "sanitized" transcript, which became available in June, showed it to have been a remarkably wide-ranging session.[19]

With this indication of increasing Congressional interest, President Nixon, in June 1969, finally ordered the sweeping review of the nation's CBW policy that Meselson and others had long sought.[20] The review was coordinated by Henry Kissinger's office, which analyzed reports prepared by government offices ranging from PSAC to the Defense Department and placed them before the National Security Council and the President for the final policy decisions.

Although Meselson did not participate directly in this review process, he was very active during this period. He prepared and circulated several papers arguing various CBW issues.[21] In addition, Meselson and Doty organized a major American Academy of Arts and Sciences conference during the summer of 1969 in order to "raise the level of discourse" about CBW, as Meselson puts it. A similar purpose was served by a seminar presented before the National Academy of Sciences in October 1969.

Meanwhile, Congress began to respond to the impact of CBW's recent bad publicity. During the same summer, 1969, the Senate Armed Services Committee decided to eliminate all funds in the fiscal 1970 budget for offensive CBW weapons development.[22] The United Nations also got into the picture when one of its study groups, composed of experts from a number of nations, including the United States, issued a detailed factual report on CBW. On the basis of this report, UN Secretary General U Thant called for a halt to the development and stockpiling of chemical and biological weapons and the elimination of these weapons from the arsenals of all nations. Finally, never one to disappoint, the Army continued to make embarrassing CBW blunders: an accident in Okinawa which led to the revelation that the Army had been storing shells and bombs loaded with nerve gas at bases around the world,[23] careless handling of a massive rail shipment of phosgene poison gas across the country,[24] and plans for an even more massive shipment of extremely dangerous nerve gas bombs (discussed in the next section of this chapter). All these developments kept strong pressure on the Nixon administration during its review of America's CBW policies.

On November 25, 1969, President Nixon announced his decision: the United States would renounce first use of lethal and "incapacitating" chemicals and would completely renounce the use of all methods of biological warfare. He also promised to resubmit to the Senate the 1925 Geneva Protocol banning first use of chemical and biological weapons. (Every major nation but the United States and Japan had ratified this treaty by 1931.)

Three months later, Nixon announced that U.S. renunciation of biological weapons would include "toxins"—biologically produced poisons, like the incredibly potent botulism toxin. The National Security Council review of the status of toxins, which had inadvertently been left unclear in President Nixon's previous announcement, had presented the President with three options:

1. Keep toxins.
2. Keep them if they can be produced synthetically.
3. Renounce toxins completely.

In choosing the third option, Mr Nixon went beyond the recommendations of any of his government advisors, including PSAC. He instead followed the advice of CBW critics like Meselson, who argued that national policy should be guided, not by semantic niceties concerning the difference between chemical and biological weapons, but by the desire for eventual worldwide CBW disarmament. Meselson obviously appreciates this decision and others which President Nixon has made on CBW-related issues, for he claims: "I'm a one issue man and CBW is my issue. As far as CBW is concerned the Nixon Administration has been a very good one." Meselson's activities in 1972, however, showed that he was aware of other issues: he worked in the Presidential campaign of Senator McGovern.

The Army's Nerve-Gas Bombs

After seeking scientific advice from highly qualified people, both within and outside the government, we have tentatively concluded that sea burial would offer the least hazard.[25]

—Acting Assistant Secretary of the Army Charles L. Poor

In April 1969, Representative McCarthy of New York found out quite by chance that the Army was preparing to ship a large quantity of obsolete poison gas across the country for disposal at sea. The poison gas at the Rocky Mountain Arsenal had become a major issue in nearby Denver as a result of reports prepared by the newly formed Colorado Committee for Environmental Information (see Chapter 12), and the Army decided that the easiest way to placate these irate citizens would be to move the gas. They proposed to send it to New Jersey and load it on old Liberty ships, which were then to be towed out to sea and sunk.

McCarthy's interest in CBW dated from the NBC television "First Tuesday" documentary on chemical and biological warfare which he had watched with his wife two months before. As he relates in his book *The Ultimate Folly*, they were shocked by what they saw.[26] When his wife asked him what he knew about CBW, he had to admit his ignorance. The next day he set out to learn more, and he arranged a Pentagon briefing for himself and a number of other Congressmen on March 4, 1969. But the Army did not seem to understand the nature of McCarthy's interest—they used the briefing as an opportunity to campaign for more funds for CBW and refused to answer McCarthy's questions fully. Ironically, McCarthy could have learned much more the same day at MIT, where March 4 had been set aside, as at several other universities, for open discussions of the misuse of science by the government: Meselson spoke there about CBW.[27]

It was inevitable that Meselson and McCarthy would soon get together. The scientist had for some time been talking to Senators and Represen-

tatives, their aides, and even some of their larger contributors, trying to arouse some Congressional interest in a curtailment of American CBW activities. Now McCarthy called Meselson for advice about the shipments of poison gas.

Meselson was slow to get excited. When McCarthy first called, Meselson told him that if the shipment only involved relatively nonvolatile susbtances like mustard gas, there should be little danger if reasonable precautions were taken. Both Meselson and McCarthy became greatly concerned, however, as the full dimensions of the Army's plans became apparent: the shipment was to consist of some 800 railroad cars filled with 27,000 *tons* of poison-gas weaponry from Rocky Mountain Arsenal and other munitions depots, including 12,000 tons of lethal GB nerve-gas bombs, 2,600 tons of leaking GB nerve-gas rockets in concrete and steel "coffins," and 5,000 tons of mustard gas.[28] Each railroad car would carry enough poison gas to wipe out several large cities. Representative McCarthy decided to raise a public alarm.

The disclosures resulted in such a general furor that the Army was immobilized. Army spokesmen announced that the shipment would be delayed pending a full investigation by a National Academy of Sciences (NAS) scientific panel. Frederick Seitz, at the time both president of the NAS and chairman of the Defense Department's top science advisory committee, the Defense Science Board, volunteered the services of the NAS for this purpose. To head the special NAS panel, Seitz appointed the famous Harvard chemist and explosives expert George Kistiakowsky. He also tried to appoint the other members of the panel, but Kistiakowsky, who was NAS vice-president and a former science advisor to President Eisenhower, insisted on appointing his own panel. Matthew Meselson was one of Kistiakowsky's appointees.[29]

As a member of the panel, Meselson visited the Rocky Mountain Arsenal and discovered that the technicians there had already accumulated considerable experience dismantling and detoxifying the nerve-gas bombs and were satisfied that they could handle all the 1.6 million "bomblets." Indeed, investigation disclosed that the Army had previously appointed an advisory committee to look into the disposal of nerve gas and that this committee had recommended that the gas be disposed of on site at the Rocky Mountain Arsenal. Despite this advice, the Army brass had quickly agreed to move the nerve gas when it became an issue in the Denver mayoral election.

The NAS panel confirmed that the fears regarding the Army's plans were well founded: they discovered that an average of fifteen derailments per day in the United States had caused, over five years, some fifty evacuations in urban areas. Eight of these incidents had involved trains carrying munitions, and just that spring an ammunition train carrying Vietnam-bound tear gas and explosives had blown up in Nevada. A helicopter inspection by Kistiakowsky of the Army's proposed train route through New Jersey turned up numerous rail crossings without guard-arms. It also became apparent that the Army's proposed emergency medical preparations—a few medics riding on each train, ready to spring out in their rubber suits at a moment's notice to administer atropine to everyone

in sight—were ridiculously inadequate in view of the quantity and rapid toxicity of the nerve gas.

Even after the gas reached port and was loaded aboard ships for disposal at sea, the eastern seaboard would not be out of danger. The Army had already dumped a large quantity of munitions, including some less dangerous gas weapons, as part of its "Operation CHASE" (Cut Holes And Sink 'Em"). But these operations were not totally uneventful: one CHASE ship broke loose while being towed to the intended dumping place, and another blew up only five minutes after sinking—apparently as a result of shifting ammunition. The NAS scientists pointed out, in their meeting with the Army officials, the possibility that the excellent acoustic coupling provided by water could cause a massive simultaneous explosion of the nerve-gas bombs when the ships upended as they started to sink. They also pointed out that heavy equipment which was loose aboard the ships could fall onto the bombs and touch off such a chain reaction. When an Army officer denied that the equipment was loose, Kistiakowsky contradicted him with a photograph he had taken only a few days before. If a major explosion of the nerve bombs were actually to occur, the resulting cloud of lethal gas could possibly be carried by the prevailing winds the hundred miles separating the proposed dumping site from New York City. Even slow seepage of the gas would poison a considerable volume of ocean.

The NAS report was released on June 25, 1969. Two days later the Army announced that it had agreed to burn the mustard gas and detoxify and dispose of the nerve gas bombs at Rocky Mountain Arsenal, as the report recommended, rather than shipping them across country.[30] The leaking nerve gas rockets could have been disassembled before they were embedded in concrete, but there now seemed to be no quick and safe method of disposal. They were eventually dumped at sea off the Florida coast. The saga of the Army's surplus poison gas then appeared to be over. But in June 1973 Denver's mayor discovered, in inquiring in Washington why the Army had reneged on its offer to give the city land from the Rocky Mountain Arsenal for a new runway, that disposal of the arsenal's nerve gas had not even begun. Again confronted with outraged citizens, the Army promised to begin destroying the gas in October 1973.[31]

The Herbicide Assessment Commission

We have considered the possibility that the use of herbicides and defoliants might cause short or long term ecological impacts in the areas concerned. . . . Qualified scientists, both inside and outside our Government, . . . have judged that seriously adverse consequences will not occur.[32]

—John S. Foster, Jr., Director of
Defense Research and Engineering,
September 1967

By 1966 the United States' use of herbicides for defoliation and crop destruction in South Vietnam had reached such a level (about a million acres annually) that many scientists in the United States were moved to protest. In June 1966 E. W. Pfeiffer, Associate Professor of Zoology at the University of Montana, submitted a resolution to the Pacific Division of the American Association for the Advancement of Science (AAAS):

> Whereas units of the U.S. Department of Defense have used . . . [chemical] warfare agents . . . in operations against enemy forces in Vietnam; and
>
> Whereas, the effect of these agents upon biological systems in warfare is not known . . . [and] the scientific community has a responsibility to be fully informed of these agents and their use in warfare because they are a result of scientific research: Therefore be it
>
> *Resolved,* That–
>
> 1. The Pacific division of the AAAS establish a committee of experts in the field of chemical warfare to study the use of CW [chemical warfare] . . . agents in Vietnam with the purpose of determining what agents have been used, the extent of their use, and the effects on all biological systems that might have been affected.
>
> 2. That the above committee make a public report of their findings at the next meeting of the Pacific division of the AAAS.[33]

Pfeiffer's resolution was referred–without recommendation–to the national office of the AAAS.

At its December 1966 meeting, the AAAS Council responded to Pfeiffer's initiative by passing a resolution expressing its concern about the "impact of the uses of biological and chemical agents to modify the environment, whether for peaceful or military purposes," and established a committee "to study such use."[34] Leaning over backward in order to avoid the appearance of entering into the political debate over Vietnam, the AAAS Council broadened Pfeiffer's resolution to the point where the committee which had been created had virtually no instructions at all.

Three months later the committee (to which Pfeiffer had been appointed) came back with the recommendation that the AAAS set up a continuing "Commission on the Consequences of Environmental Alteration" and that various studies be initiated. Vietnam was mentioned as among "areas where massive programs are in progress" and where, the committee suggested, studies of the effects of defoliants might be valuable. But the only suggestion of who might undertake the suggested studies referred to the National Academy of Sciences. Pfeiffer submitted a minority report opposing this suggestion because of the Pentagon's use of the NAS "as a source of advice for biological warfare effort" and also because of NAS's sponsorship of a postdoctoral research fellowship program at Fort Detrick, the Army's main biological warfare research center.[35]

In September 1967 the AAAS sent a letter to Secretary of Defense McNamara suggesting a study of the consequences of the U.S. defoliation program in South Vietnam by either the NAS-NRC, a panel of the President's

Science Advisory Committee, or an independent commission responsible to the Secretary of Defense. The letter was answered by Director of Defense Research and Engineering John S. Foster, Jr., who reassured the AAAS that

> qualified scientists, both inside and outside our Government, and in the governments of other nations, have judged that seriously adverse consequences will not occur. Unless we had confidence in these judgements, we would not continue to employ these materials.[36]

But when the president of the AAAS wrote back asking for more information on the technical basis for Foster's "confidence," the Director of Defense Research and Engineering was quite vague, referring only to a "consensus of informed opinion" of fifty to seventy individuals in the absence of "hard data."[37]

Adding to the assurances of his first letter, Foster said that he had commissioned "a leading nonprofit research insititute to thoroughly review and assess all current data in this field" and that he had requested the National Academy of Sciences' National Research Council to set up a panel to "review the results of the study and to make appropriate recommendations concerning it."[38] Four months later, the Midwest Research Institute (MRI), under Department of Defense contract, had reviewed and summarized the literature on the ecological impact of the defoliation program on South Vietnam, and their report had in turn been reviewed by an NAS review panel. The NAS review concluded that the MRI report had adequately surveyed the abundant data on techniques of herbicide use in "vegetation management," adding:

> However, the scientific literature provides markedly less factual information on the ecological consequences of herbicide use and particularly of repeated and heavy herbicide applications.[39]

The President of the NAS commented: "Some research in this area is now under way but much more needs to be done."[40] Thus in January 1968, eighteen months after Pfeiffer had asked for a study of the ecological impact of defoliation on South Vietnam because "the effect of these agents upon biological systems in warfare is not known," an NAS panel had reviewed a 369-page summary of 1,500 references and interviews with 147 persons–and had come to essentially the same conclusion.

It seemed to Pfeiffer that it was time for the AAAS to act on his original recommendation. He asked somewhat plaintively:

> Are American scientists capable of making an independent study or not? So far the situation has been up in the air. You cannot get the AAAS board of directors to commit themselves to such a study, and I don't think the average AAAS member knows that the study was ever being considered.[41]

Pfeiffer expressed the hope that the AAAS should at least sponsor an extensive symposium on the subject, which "would hopefully stimulate people to go into the field and get data on the effects of herbicides."[42] But, six months later (July 1968), after examining the MRI report, the AAAS Board of Directors again passed the buck by publicly issuing the recommendation that

a field study be undertaken under the auspices and direction of the United Nations, with the participation of Vietnamese scientists and scientists from other countries, and with cooperation, support, and protection provided by the contending forces in the area.[43]

This recommendation was sent to the Secretary General of the UN and to the U.S. Secretaries of State and Defense.

The response from the UN was a letter assuring the AAAS that the Secretary General was giving "the matter of chemical and bacteriological weapons . . . his very close attention."[44] The State Department replied that

such studies in combat areas are obviously difficult at present. The United States will be happy to cooperate in responsible long-term investigations of this type as soon as practicable.[45]

And John Foster replied for the Defense Department:

We have continued to gather data and reevaluate all available data and technical judgements. While there are a number of scientific questions left unanswered by available studies, these questions apparently would not be answered by additional, short-term investigations. On balance, we continue to be confident that the controlled use of herbicides will have no long-term ecological impacts inimical to the people and interests of South Vietnam.[46]

Two months later (September 1968), Ellsworth Bunker, U.S. Ambassador to South Vietnam, released the findings of an interagency committee which had reviewed the U.S. defoliation operation. Most of the statements in the report were vague, reflecting a continuing absence of hard data on either the military usefulness or the environmental impact of defoliation. At the end of the report, however, murky and unsubstantiated statements gave way to a very specific conclusion:

Thus, in weighing the overall costs, problems, and unknowns of the herbicide programs against the benefits, the committee concluded that the latter outweigh the former and that the programs should be continued.[47]

The AAAS had thus exhausted the last alternative to taking its own initiative. In December 1968 the AAAS Council finally directed

the AAAS staff to convene, as soon as possible, an ad hoc group involving representation of interested national and international scientific organizations to prepare specific plans for conduct of . . . a field study with the expectation that the AAAS would participate in such a study within the reasonable limits of its resources.[48]

Two-and-one-half years had now passed since Pfeiffer had first submitted his resolution, and over 3 million additional acres of South Vietnam had been sprayed with herbicides. Nothing significant was done during the next year, however, to implement the Council's directive.

Pfeiffer is not one to be stopped easily. Meselson describes him as "a real pioneer type—if he sees a problem, he follows through and explores it wherever

it may lead." Pfeiffer decided to undertake an expedition to Vietnam himself. He announced that he and another zoologist, Professor G. H. Orians, would voluntarily conduct a preliminary herbicide assessment expedition to Vietnam under the sponsorship of the small Society for Social Responsibility in Science. Among the objectives of the mission were

to stimulate awareness among scientists of the need for an intensive and long-term study of the effects of military uses of chemical agents in Vietnam [and] to demonstrate the possibility of obtaining meaningful information even with limited funds and personnel.[49]

The expedition was conducted during the second half of March 1969.

In December 1969, the AAAS finally committed itself to action by appropriating $50,000 to fund a Herbicide Assessment Commission which would go to Vietnam to make a pilot study of the environmental and health impact of the defoliation program. Matthew Meselson was invited to organize the study.

Meselson hired Arthur H. Westing, an expert on forest ecology from Windham College in Vermont, as director of the HAC. Both men then surveyed the literature and circulated a proposed list of study topics to over 200 scientists. In June 1970 a five-day working conference at Woods Hole, Massachusetts, attended by twenty-three specialists in such fields as tropical ecology and forestry, helped further to define specific problems for systematic study. Finally, in August and September 1970, Meselson and Westing made a five-week tour of South Vietnam, accompanied by John D. Constable, Professor of Surgery at the Harvard Medical School, and Robert E. Cook, a graduate student in biology at Yale. Constable had already been to South Vietnam representing a Boston-based group called the Physicians for Social Responsibility, which intended to bring severely burned Vietnamese youngsters back to the United States for treatment. This group had received the impression from newspaper reports that many children had suffered burns as a result of U.S. napalm attacks and had survived. But when Constable returned he had to report that he had been able to find very few such victims in the South Vietnamese hospitals that he visited. Meselson was impressed: here was a man who had gone to Vietnam expecting to find something, hadn't found it—and was honest enough to admit as much to the newspapers when he came back. Meselson invited Constable to join the HAC.

Without the cooperation of U.S. and South Vietnamese officials, Meselson and his group could not expect to accomplish much in South Vietnam. Before the HAC left, therefore, the AAAS wrote to Secretary of Defense Laird and to the State Department's Agency for International Development (AID) asking for their cooperation. The response from AID was generous: the group was offered lodgings, food, ground transport, and office facilities while in South Vietnam. But the cooperation sought from the Pentagon was more important—and it was not forthcoming: requests for the locations and dates of herbicide spraying missions were brusquely refused and attempts made in Washington to obtain helicopter transport to sprayed areas were unsuccessful.

The HAC thus arrived in Vietnam armed only with the hospitality of AID and with a letter addressed "To Whom It May Concern" from H. Bentley Glass, Chairman of the Board of the AAAS. It was obvious that the average U.S. official or military officer in South Vietnam was unlikely to be much impressed by such a letter, and it certainly would not get the HAC a helicopter. Meselson therefore began by visiting the U.S. Embassy and the office of the South Vietnamese Prime Minister. When he emerged he had letters of introduction that could be expected to carry some weight.

The HAC's first helicopter ride was obtained by using press cards which had been provided to the group by *Science*, a weekly journal published by the AAAS. But this seemed too much like false pretenses, so they did not use the press cards again. Their next helicopter rides were obtained through the courtesy of the U.S. Embassy—but the Embassy's own access to helicopter transport was so limited that they soon turned elsewhere. When they finally went to the South Vietnamese Army, the letter from the Prime Minister got them complete cooperation: the Vietnamese were willing to order unlimited amounts of helicopter transport for Meselson and his colleagues—from the U.S. Army.

In the meantime Meselson had written to General W. B. Rosson, acting commander of U.S. forces in South Vietnam, renewing his request for information about U.S. herbicide operations in South Vietnam, for helicopter transport, for "logistic and security support to conduct one or two ground inspections," and for statistics recently gathered by the U.S. Army on the incidence of stillbirths and birth defects in South Vietnam.[50] The last item on Meselson's list referred to a study that had been initiated following the release of the Bionetics Research Laboratory study (funded by the U.S. Department of Health, Education, and Welfare) indicating that the herbicide 2,4,5-T is a teratogen.

General Rosson replied that the information on herbicide targets and birth defects Meselson was asking for was classified but that he would be glad to provide helicopter transport. The HAC found this offer virtually unrestricted; they had only to put in a call to get a helicopter whose pilot had orders to "fly as directed" by Meselson, subject only to limitations of safety. The HAC also had access to airplanes belonging to the Vietnam rubber growers' association, whose headquarters in Paris Meselson and Westing had visited on the way to South Vietnam. These airplanes had the advantage that the Vietcong knew them and would not shoot at them; but they were much more difficult than helicopters to take aerial photographs from, so the HAC stuck mainly with the helicopters.

Many of Meselson's flights were with Professor Pham-hoang Ho, a professor of botany who also happened to be South Vietnam's Minister of Education. (Later, after the HAC's report helped bring about the end of the U.S. defoliation program, Professor Ho dedicated his book on the flora of Vietnam to Meselson.) The second in command of the U.S. Chemical Corps in Vietnam also accompanied them. Meselson thought that the Army should be familiar with how the HAC had worked and know the basis for its ultimate conclusions.

On the ground, South Vietnamese professors and students of medicine and zoology helped the HAC collect samples of plants, fish, hair, mother's milk, and so on. The samples were immediately frozen in a 200-pound container of liquid nitrogen. The HAC also recorded interviews with sixty farmers and village officials in or near defoliated areas, including two Montagnard villages.

Although the Pentagon had been uncooperative, the HAC found American military officers in Vietnam generally friendly and open. The HAC did not need very much guidance to find defoliated areas, however. South Vietnam is not a very large country if you have a helicopter, and the defoliated areas were always distinguishable by the dead trees that they contained—the enormous doses of herbicides had not only defoliated but killed millions of trees.

The morning that the Herbicide Assessment Commission left South Vietnam, Meselson had an appointment with General Creighton Abrams, Commander of U.S. forces in Vietnam, who had just returned to duty after undergoing surgery. The interview lasted the entire morning, and Meselson obtained the definite impression that Abrams did not think very much of herbicide use. This impression was confirmed the following December when the *Washington Post* obtained a copy of a cable that General Abrams and Ambassador Bunker had sent jointly to Washington requesting permission to terminate the crop-destruction program.[51] A questionnaire distributed later by the Chief of Army Engineers to officers who had observed the results of defoliation operations in South Vietnam revealed a similar lack of enthusiasm. The responses averaged out to the conclusion that the value of herbicides had been "slight."[52]

When the HAC returned to the United States, the process of analysis and report writing began—and was still going on three years later. Meselson was as creative as usual in obtaining assistance in analyzing the samples he had brought back from Vietnam. For example, since one of the herbicides used for crop destruction, cacodylic acid, is over 50 percent arsenic, it was natural to ask whether it had caused any arsenic poisoning. Meselson got help both from the Boston Metropolitan District Police and from MIT nuclear physicist Lee Grodzins in measuring trace amounts of arsenic in the samples of human hair which the HAC had collected.

The Herbicide Assessment Commission gave a preliminary report on its findings at the annual meeting of the AAAS in Chicago in December 1970. In brief, their findings were as follows:

> • • • About half the area of South Vietnam's coastal mangrove forests had been sprayed. U.S. Agriculture Department botanist Dr. Fred S. Tschirley had previously reported that mangroves are killed by herbicide spraying. The pictures that Meselson showed of the lifelessness of these areas years after the spraying gave ample confirmation of this observation. These photographs were widely reproduced in the press and had perhaps the greatest public impact of any item reported by the HAC.

• • • About 20 percent of South Vietnam's relatively mature hardwood forest—which covers almost one-half the area of South Vietnam—had been treated with herbicides, a third of it more than once. Dr. Barry Flamm, chief of the AID Forestry Branch, had previously concluded that a single spraying causes 10 to 20 percent killing of marketable trees, and successive treatments 50 to 100 percent mortality.

• • • A considerable fraction of the crop land in South Vietnam's extensive highlands had been sprayed. These highlands support a population of about a million persons—Montagnard tribesmen—at a subsistence level.

• • • The Commission found some evidence linking the defoliation program with increases in the prevalence of still births in rural Vietnam, but in view of all the war-related disruptions and other factors which might have affected the reported numbers, the evidence did not appear conclusive. The HAC therefore urged further study.[53]

Two weeks before this public presentation, the HAC had given briefings on its findings at both the State Department and the White House (the Defense Department had declined the offer). This was followed, on the opening day of the AAAS meeting, by a surprise announcement from the White House of "an orderly, yet rapid, phaseout of the herbicide operations."[54] We can only speculate on the reasons for this move. But anticipation of the public's revulsion at the vast destruction of Vietnamese forests and food crops must have contributed. At the same time, the request from General Abrams and Ambassador Bunker for an end to the crop-destruction program, along with a general lack of enthusiasm for the defoliation program among Army officers in Vietnam, ought to have made the decision a relatively easy one to make.

The most recent development coming out of the HAC's work—the discovery that dioxin had indeed accumulated in the South Vietnamese food chain—has already been mentioned at the beginning of this chapter. Another development was that Congress ordered in its Military Procurement Authorization Act for the fiscal year 1971 that the Secretary of Defense

undertake to enter into appropriate arrangements with the National Academy of Sciences to conduct a comprehensive study and investigation to determine (A) the ecological and physiological dangers inherent in the use of herbicides, and (B) the ecological and physiological effects of the defoliation program carried out by the Department of Defense in South Vietnam.[55]

Congress asked in the same legislation that the NAS report be submitted by January 31, 1972, but the NAS asked for and received two extensions from the Secretary of Defense and the chairmen of the House and Senate Armed Services Committees.

When the NAS report finally came out in January 1974, it confirmed the seriousness of a number of herbicide effects: reports of illness and death—especially among Montagnard children—following exposure to herbicides; the destroyed mangrove forests would probably take about 100 years to regenerate, they had been invaded by malaria-bearing mosquitos, and the productivity of

their offshore fishing grounds had been reduced; defoliation and crop destruction operations had so reduced food supplies in some areas that they had "resulted in the displacement of people from their homes and had contributed to the urbanization of South Vietnam"[56]; and finally the report observed that in South Vietnamese cities herbicides had come to be seen as "an emotionally charged symbol standing for many apprehensions and distresses, especially those for which Americans are blamed."[57] Meselson served on the NAS Report Review Committee panel which reviewed the herbicide report and improved it substantially.[58]

Some Observations

Meselson feels very strongly that the battle against chemical and biological warfare is an all-or-nothing affair. Unless the United States joins with the other nations of the world in ratifying the Geneva Protocol of 1925 which outlaws CBW, he feels that all the successes in the struggle against CBW will soon be forgotten and the whole battle will in a few years have to be fought once again.

Of course, many scientists besides Meselson have played an important role in the opposition to chemical and biological weapons. If we have emphasized Meselson's contributions, we have done so in order to show how effective a single individual can be and how useful it is to be flexible in tactics.

Meselson gained his initial acquaintance with CBW as an "insider," and he has continued to have access to secret data as an advisor to the Arms Control and Disarmament Agency. He has never made public classified information; rather, his clearance enabled him to make sure that his arguments could not be refuted by secret information and established his competence and "credentials" inside the government as well as outside.

Meselson has consistently utilized the advantages of both "insider" and "outsider" positions with remarkable success. Acting in the manner of an insider, he helped the Army make a wise decision on the disposal of its nerve gas, and later he was influential during the Nixon administration's CBW policy review. As an outsider he helped to force first the termination of 2,4,5-T use in Vietnam and later the ending of the entire defoliation and crop-destruction program there. He has also helped to educate Congress and to create and inform the scientific community and popular constituency without whose continuing pressure the "insider" successes would not have been possible. Perhaps most noteworthy of all, in his entire career as an anti-CBW activist Meselson has compromised neither his "future effectiveness" nor his personal scientific integrity.

NOTES

1. This information, and much other material in this chapter, comes from interviews with Meselson. That there were many dwellings in the valley was pointed out by Meselson and John Constable of the HAC in a letter to Ellsworth Bunker, American Ambassador to South Vietnam, November 12, 1970.

2. Robert Baughman and Matthew Meselson, "An Analytical Method for Detecting Dioxin" (paper presented at the Conference on Dibenzodioxins and Dibenzofurans held by the National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina, April 2, 1973). (To be published in *Environmental Health Perspectives.*) See also "Herbicides: AAAS Study Finds Dioxin in Vietnamese Fish," *Science* 180 (1973): 180.

3. David E. Rosenbaum, *New York Times,* November 26, 1969, p. 17.

4. Quoted in Seymour M. Hersh, *Chemical and Biological Warfare: America's Hidden Arsenal* (Garden City, N. Y.: Doubleday Anchor, 1969; originally published in 1968), p. 18. (This reference is referred to below as *CBW.*)

5. Quoted in ibid., p. 19.

6. Ibid.

7. See Jacquard H. Rothschild, "Germs and Gas: The Weapons Nobody Dares Talk About," *Harper's,* June 1959, p. 8.

8. Hersh, *CBW,* p. 28ff.

9. Richard D. McCarthy, *The Ultimate Folly* (New York: Vintage, 1969), pp. 62, 66.

10. Matthew S. Meselson, review of *Tomorrow's Weapons, Chemical and Biological,* by Jacquard H. Rothschild, *Bulletin of the Atomic Scientists,* October 1964, pp. 35-36.

11. Matthew S. Meselson, "A Proposal to Inhibit the Development of Biological Weapons," *Proceedings of the 14th Pugwash Conference on Science and World Affairs* (April 1965), pp. 297-304. For more information on the Pugwash anti-BW efforts see Virginia Brodine, "Detection of Biological Weapons," *Scientist and Citizen,* August-September 1967, p. 168, and Hersh, *CBW,* p. 265. The "Pugwash" conferences began under the sponsorship of industrialist Cyrus Eaton, and were initially held at Eaton's estate in Pugwash, Nova Scotia—hence the name. CBW was first discussed at length in the Pugwash conferences in 1959, and it became a major focus of discussion at 1965 and subsequent meetings. See also J. Rotblat, *Scientists in the Quest for Peace: A History of the Pugwash Conferences* (Cambridge, Mass.: MIT Press, 1972).

12. For a review of U.S. CBW activities in South Vietnam up to 1967, see Hersh, *CBW,* esp. pp. 123-160, and Arthur W. Galston, "Warfare With Herbicides in Vietnam," in *Patient Earth,* ed. John Harte and Robert H. Socolow (New York: Holt, Rinehart, and Winston, 1971), pp. 136-150.

13. *Harvard Alumni Bulletin,* March 11, 1967, pp. 16-19, 30.

14. *New York Times,* September 20, 1966, p. 1.

15. *New York Times,* February 15, 1967, p. 1.

16. Hersh's book (footnote 4) contained a great deal of previously classified information. Hersh had told Meselson that he was studying CBW, but he did not attempt to obtain any information from Meselson and thereby jeopardize Meselson's security clearance.

17. The Dugway incident received considerable attention in the press. The Army's final admission of guilt was reported in the *New York Times,* May 22, 1969, p. 14. A good account is Virginia Brodine, Peter Gaspar, and Albert Pallmann, "The Wind from Dugway," *Environment,* January-February 1969, pp. 2-9, 40-45; reprinted in *Our World in Peril: An Environment Review* (Greenwich, Conn.: Fawcett, 1971), pp. 77-101, Sheldon Novick and Dorothy Cottrell, eds.

18. These television programs may have been inspired by the earlier BBC documentary on CBW: "A Plague on Your Children."

19. U.S. Congress, Senate, Commiteee on Foreign Relations, *Chemical and Biological Warfare,* 91st Cong., 1st sess., April 30, 1969 (sanitized and printed June 23, 1969). Excerpts from Meselson's testimony were reprinted in *Bulletin of the Atomic Scientists,* January 1970, pp. 23-24.

20. *New York Times,* June 17, 1969, p. 1.

21. Examples of unpublished papers by Meselson during this period are "The Position of Various Nations During the Interwar Period Regarding the Use in War of Tear Gas Under the Geneva Protocol of 1925" (May 1969), "CS in Vietnam" (July 1969), "The United States and the Geneva Protocol of 1925" (September 1969), and "What Policy for Toxins?" (January 1970).

22. *New York Times,* July 4, 1969, p. 1. The Senate later adopted, by a 91-0 vote, a measure placing numerous restrictions on development, transportation, and storage of CBW munitions (*New York Times,* August 12, 1969, p. 1).

23. *New York Times,* July 19, 1969, p. 1.

24. *New York Times,* August 16, 1969, p. 1; September 9, 1969, p. 33; September 10, 1969, p. 44.

25. Quoted in McCarthy, *The Ultimate Folly,* p. 105, from Mr. Poor's testimony before a subcommittee of the House Foreign Affairs Committee, May 1969.

26. Ibid., pp. viii, 126.

27. Matthew Meselson, "Controlling Chemical and Biological Weapons," in Jonathan Allen, ed. *March 4* (Cambridge, Mass.: MIT Press, 1970), pp. 151-160.

28. Phillip M. Boffey, "CBW: Pressure for Control Builds in Congress, International Groups," *Science* 164 (1969): 1376; "Academy Changes Army Gas Dump Plan," ibid., 165 (1969): 45.

29. The information in this and the following three paragraphs is mainly from interviews with Meselson and Kistiakowsky.

30. Phillip M. Boffey, "Academy Changes Army Gas Dump Plan," *Science* 165 (1969): 45.

31. "Hidden Stores of Poison," *Time,* July 23, 1973, pp. 61-2.

32. Letter from Foster to Don Price, AAAS president, quoted in a statement by the AAAS Board of Directors, "On the Use of Herbicides in Vietnam," *Science* 161 (1968): 253.

33. Quoted in U.S. Congress, House, Committee on Science and Astronautics, *Technical Information for Congress,* Report to the Subcommittee on Science, Research and Development, prepared by the Science Policy Research Division, Congressional Research Service, Library of Congress, April 15, 1971, p. 556. This report contains an eighty-page case study of the involvement of the AAAS in the Vietnam herbicide-use controversy. Our discussion of the background to the AAAS decision to set up its Herbicide Assessment Commission is based on this reference.

34. Quoted in ibid., p. 559.

35. Ibid., p. 560.

36. Quoted in ibid., p. 561. (This is part of the same quote which appears at the beginning of this section.)

37. Quoted in ibid., p. 562.

38. Quoted in ibid., p. 562.

39. Quoted in ibid., p. 567.

40. Quoted in ibid., p. 567.

41. Quoted in ibid., p. 570. (From an interview in *Scientific Research,* January 22, 1968, p. 14).

42. Quoted in ibid., p. 569.

43. Quoted in ibid., pp. 571-572.

44. Quoted in ibid., p. 573.

45. Quoted in ibid., p. 574.

46. Quoted in ibid., p. 574.
47. Quoted in ibid., p. 576.
48. Quoted in ibid., p. 581.
49. Quoted in ibid., p. 585.
50. Letter from Matthew Meselson to General W. B. Rosson, Deputy Commander, U.S. Military Assistance Command, Vietnam, August 12, 1970. (From interview with Meselson.)
51. *New York Times,* December 17, 1970, p. 13.
52. U.S. Army, Office of the Chief of Army Engineers, *Herbicides and Military Operations,* Engineer Strategic Studies Group, February 1972. The first two volumes are unclassified. The third, which discusses primarily possible future wars in which herbicides would be useful, is classified but was reviewed in "Defoliation: Secret Army Study Urges Use in Future Wars," *Science and Government Report,* August 18, 1972. See also Deborah Shapley, "Herbicides: DOD Study of Viet Use Damns With Faint Praise," *Science* 177 (1972): 776.
53. Matthew S. Meselson, Arthur H. Westing, John D. Constable, and James E. Cook, "Preliminary Report of the Herbicide Assessment Commission," presented at the AAAS annual meeting, Chicago, December 30, 1970; reprinted in *Congressional Record* 118 (1972):S3226-33. See also Phillip Boffey, "Herbicides in Vietnam: AAAS Study Runs into a Military Roadblock," *Science* 170 (1970):42; "Herbicides in Vietnam: AAAS Study Finds Widespread Devastation," ibid., 171 (1972):43.
54. Quoted in *New York Times,* December 27, 1970, p. 5.
55. Quoted in *The Effects of Herbicides in South Vietnam: Summary and Conclusions* (Washington: National Academy of Sciences, 1974), p. vii. The best available figures for the total sprayed areas in South Vietnam are given in this report.
56. Ibid., p. S-12.
57. Ibid., p. S-13.
58. Deborah Shapley, "Herbicides: Academy Finds Damage in Vietnam after a Fight of Its Own," *Science* 183 (1974):1177.

CHAPTER 12

Watching the Federal Government in Colorado: The Colorado Committee for Enviromental Information

The history of the Colorado Committee for Environmental Information provides an excellent illustration of the impact that a public interest science group can have at the state level. The committee was most active during the period 1968-1970, when it initiated and informed major debates in Colorado on the hazards connected with three federal programs: (1) the storage of huge quantities of nerve gas at the Rocky Mountain Arsenal near downtown Denver, (2) the continued operation of Dow Chemical's Rocky Flats Plant outside Denver after a disastrous release of intensely radioactive plutonium smoke from the facility had almost occurred and (3) the developmental tests of a method to stimulate the production of natural gas by underground nuclear explosions.

The Rocky Mountain Arsenal

At the Rocky Mountain Arsenal on the outskirts of Denver, the army has manufactured and stored vast amounts of nerve gas and other war gases; in 1968 this stockpile included more than 20,000 nerve-gas cluster bombs containing about 20 gallons of nerve gas apiece.[1] At the height of the cold war, the commander of the arsenal had bragged to a local newspaper reporter that

the gas from a single bomb the size of a quart fruit jar could kill every living thing within a cubic mile, depending on the wind and weather conditions. . . . A