War and Nature

Fighting Humans and Insects with Chemicals from World War I to *Silent Spring*

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Introduction

It has been called "the nation's most ironic natural park." The Rocky Mountain Arsenal National Wildlife Refuge near Denver is one of the premier urban wildlife refuges in the nation. It is large (twenty-seven square miles), popular (50,000 people visit each year), and bountiful (some 300 species of wildlife, including candidates for the endangered species list, inhabit one of the largest tracts of shortgrass prairie in the West). At the same time, the refuge is one of the most toxic sites in the world. By-products of nerve gases, now-banned pesticides, and other lethal compounds contaminate the land and groundwater. A Superfund site, the refuge is the focus of a $2 billion cleanup effort expected to last well into the twenty-first century.[1]

The refuge seems ironic because, as a journalist wrote, it has "a lot more to do with nurturing life than with the arsenal's long mission of death."[2] Another word often used to describe the refuge (and other military sites hospitable to wildlife) is "paradoxical."[3] "Irony" and "paradox" are words we use when the world does not work the way we think it should. They are also arrows pointing to new ways of looking at familiar topics.

This book is an effort to rethink the relationship between war, nature, and human history. Long cultural traditions have given us little practice thinking about them at the same time. Since at least the days of the Old Testament, we have seen war and interactions with nature as separate, even opposite, endeavors. One of the most popular ways of expressing this idea came from Isaiah: "They shall beat their swords into plowshares, and their spears into pruning hooks: nation shall not lift up sword against nation, neither shall they learn war any more."[4] Military strategist Karl von Clausewitz defined war as "a form of *human* intercourse" and virtually ignored nature.[5] Similarly, we have often seen a distinction between war and the military, on the one hand, and peace and civilian life, on the other. As one observer put it, Americans in particular "are inclined to see peace and war as two totally separate quanta. War is abnormal and peace is normal and returns us to the status quo ante."[6]

With a few exceptions, even historians who have broken down other boundaries have left the war–nature divide intact. Military historians have pushed beyond studies of battles and armies to examine the impact of military institutions on civilian society – but rarely on nature. Environmental historians have emphasized the role of nature in many events of our past – but rarely in war. Historians of technology have analyzed the impact of military technology on society – but rarely on nature. Cultural historians have emphasized the impact of war on the way people interacted with each other – but rarely its impact on the way people interacted with the millions of other species on the planet.[7]

This book challenges these traditions. Its thesis is that war and control of nature coevolved: the control of nature expanded the scale of war, and war expanded the scale on which people controlled nature. More specifically, the control of nature formed one root of total war, and total war helped expand the control of nature to the scale rued by modern environmentalists. This book

makes this argument through a case study, the interaction between chemical warfare and pest control in the twentieth century.

These might not seem the most obvious cases to study. Since 1945, nuclear weapons have stood as icons of military technology and the threat of war. And, probably because we think of insects as trivial or low-status creatures, pest control is not a glamorous field. But these images have obscured our vision. Although clearly significant, atomic weapons were not the only important weapons of mass destruction. Atomic bombs killed an estimated 100,000 people; chemical weapons killed about 90,000 people in World War I and 350,000 in World War II, plus the victims of Nazi gas chambers. Chemical weapons framed the century: a treaty designed to limit poison gas in warfare ushered in the twentieth century, and another treaty designed to eliminate chemical warfare ushered it out. In between, chemical weapons wrought profound changes in civilian life, science, and war. The seeming triviality of insects, on the other hand, was one of the reasons they were so important. Two examples from wartime are illustrative: commanders often ignored the potential of insects to transmit diseases, with disastrous results (in the Pacific in World War II, for example, malaria felled American soldiers eight times faster than Japanese soldiers did); and popular views of insects as trivial made them especially valuable to propagandists seeking to mold images of human enemies. Among experts, though, countering insect problems was seen as a Nobel-class issue: for discovering DDT's insecticidal properties, Paul Müller won the Nobel Prize for Medicine or Physiology in 1948.[8]

These two endeavors – chemical warfare and pest control – expanded each other on three levels. *Ideologically,* pest control created a set of values that warriors used to argue for combating and even annihilating human enemies. War created a powerful motive and rationale for a huge leap in the scale on which people

controlled insects.[9] *Scientifically and technologically,* pest control and chemical warfare each created knowledge and tools that the other used to increase the scale on which it pursued its goals. *Organizationally,* war (and sometimes peace) stimulated the creation, growth, and linkage of military and civilian institutions devoted to pest control and chemical warfare, accelerating developments in both spheres.

Neither chemical warfare nor pest control was new in the twentieth century. The first recorded use of poison gas in war came in 428 B.C., when Spartans besieging Plataea tried to oust defenders by burning wood soaked in pitch and sulfur under city walls. Various succeeding armies used suffocating and incendiary mixtures to attack their enemies. One of the most famous, Greek Fire, burned and produced suffocating fumes while floating on water.[10] By the nineteenth century, however, poison chemicals had lost favor. In the Crimean War, British chemist Lyon Playfair proposed without success that naval shells be loaded with cacodyl cyanide (an arsenic compound) and fired into Russian ships. In the American Civil War, Union leaders rejected several proposals for gassing Confederate soldiers with chlorine, chloroform, and hydrogen chloride.[11]

The ideology of "civilized war" contributed to excluding gas from warfare. By the nineteenth century, professional soldiers had developed an unwritten code of behavior designed to limit harm to themselves and to civilians. The Hague Conventions of 1899 and 1907 advanced this common understanding by (among other things) defining and specifying the rights of combatants, noncombatants, neutrals, prisoners of war, journalists, and cities. One of the "declarations" of the 1899 conference banned the use of projectiles designed to spread "asphyxiating and deleterious gases." Twenty-seven nations ratified or adhered to the declaration, including France, Germany, Italy, Japan, Russia, and Great Britain.[12]

The United States rejected the gas declaration. Naval theorist and American delegate Alfred Thayer Mahan persuaded an initially divided delegation to take this stand. Poison gas might be more humane than existing weapons, Mahan argued, and could produce a decisive result.[13] Another delegate, Columbia University President Seth Low, agreed, reasoning that no such projectiles existed so their effect was "purely hypothetical." He said it was not "clear why shells which asphyxiate only should be forbidden, while shells which both explode and asphyxiate should be permitted."[14] The U.S. Senate followed suit and rejected the declaration banning asphyxiating gases.[15] Ironically, it ratified another "convention" from the Hague Conference that forbade use of "poison or poisoned weapons." The reason is unclear; perhaps the Senate overlooked the provision, which was only six words in a much longer convention on "laws and customs of war on land."[16]

Insecticides also had a long history. Over the centuries, various dusts and concoctions, many made from plants, found their way into farm fields and homes to control insects. Some two thousand years ago, Pliny urged the use of salt and ashes to keep worms away from fig trees, burning a plant product called galbanum to rid gardens of flies, and applying beaten larkspur to "kill vermin in the head."[17] In 1658, Thomas Moufet (also spelled Moffat and Muffet, and perhaps the father of the miss who met a spider while eating curds and whey) recommended fern root, penny royal, rue, and "the dregs of Mares-piss."[18] These recommendations likely grew out of informal experiments that formed the basis for folk knowledge. Pyrethrum was the most important botanical insecticide in the American market. Ground from the petals of several species of chrysanthemum, it achieved prominence as "insect powder" before 1800. First Persia, then Dalmatia (part of Austria-Hungary at the time), then France became major exporters in the eighteenth and nineteenth cen-

turies.[19] Unfortunately, pyrethrum was too expensive to use widely in agriculture. Pyrethrum flowers were picked entirely by hand, which concentrated production in countries where labor was cheap.[20] These investments in land and labor made pyrethrum too costly to use profitably on any but the most valuable crops. It was employed primarily in households to kill flies, and even then the quantities were not large.[21]

In the nineteenth century, arsenic joined pyrethrum as a major active ingredient in insecticides, especially in agriculture. Although its first such uses are obscure, an arsenic powder called Paris green became popular in the United States in the 1860s for use on the Colorado potato beetle.[22] The success of Paris green against the potato beetle led apple raisers of the East Coast to try it against canker worm and codling moth in the 1870s. It worked again. By 1896, the United States consumed 2,000 tons of Paris green annually. In 1892–1893, a chemist working for the Massachusetts Gypsy Moth Commission developed a new arsenic insecticide, lead arsenate, which killed insects over long periods because it adhered to foliage. The well-publicized campaign against the gypsy moth doused lead arsenate on trees quite freely. Farmers and researchers soon found lead arsenate effective against elm leaf beetles, grape worms, and codling moths. The U.S. Patent Office denied the Gypsy Moth Commission's chemist a patent, turning the manufacture of lead arsenate into an open business. In 1907–1908, at least eighteen concerns manufactured about 2,500 tons of lead arsenate valued at more than half a million dollars.[23]

Pest control involved ideas as well as technology. The evolution of a word used by Americans for both human and insect enemies, "exterminate," suggests that the ideology of eradication appealed to long-standing values. The Latin root meant "to drive beyond the boundaries." Humans and insects that did not respect boundaries – of home, farm, or country – ought to be driven out, this

term implied. By the fourth century, "exterminate" had taken on another connotation: "to destroy utterly" or annihilate.[24]

What set the twentieth century apart from earlier epochs was the *scale* on which people could annihilate human and natural enemies. Our narrative begins with World War I, when modern chemical warfare debuted. It ends with the publication of *Silent Spring*, the best-selling book by Rachel Carson that helped catalyze the modern environmental movement by characterizing pest control as a self-defeating form of warfare. Between these events, the United States gained unprecedented power over people and nature by mobilizing ideas, technology, institutions, and nature more efficiently than ever before. The result was wonderful and horrifying. Around the time of World War I, James J. Walsh published a book titled *The Thirteenth: Greatest of Centuries*.[25] Had Walsh lived to see the new millennium, what superlative title might he have attached to a book about the twentieth century? My nomination would be *The Twentieth: Most Ironic of Centuries*.

On the one hand, the quality of human life accelerated at an unheard-of rate. Simple survivorship was a good measure. In the last fifty years of the twentieth century, the human population nearly tripled. A drop in the death rate – not a rise in the birth rate – was the key to this rapid increase. As one expert put it, the human population did not surge because people "suddenly started breeding like rabbits: it is just that they stopped dying like flies."[26] This book tells part of that story: people stopped dying like flies because they got better at controlling nature, including flies and other insects that spread diseases and reduced crop yields.

On the other hand, the rate at which human beings killed each other also soared in the twentieth century. World War I killed more people than all nineteenth-century wars combined. World War II accounted for more than half the people killed in wars over the past two thousand years. Population growth contributed

to the surge in numbers of deaths, but the *rate* at which people died also jumped. By one estimate, people in the twentieth century were fourteen times more likely to die in war than were people in the sixteenth century.[27] Here, too, this book tells part of that story: the main agent of civilian deaths in cities in World War II was fire, and chemical weapons (incendiaries) started most of those fires.

The irony of this combination grew not just out of coincidence in time; it grew out of causal interaction. Americans got better at saving lives partly *because* they got better at taking them. Americans got better at taking lives partly *because* they got better at saving them. Peace and war did not inhabit separate spheres. As one of the figures in this book said, Americans lived a world of "peaceful warfare."

To understand how and why, we have to think about war, nature, and politics at the same time. One of the most insightful analysts of American society, Alexis de Tocqueville, provides some guidance. Tocqueville thought the "chief circumstance" encouraging American democracy was nature. "Their ancestors gave [Americans] the love of equality and of freedom," Tocqueville wrote, "but God himself gave them the means of remaining equal and free, by placing them upon a boundless continent.... In the United States not only is legislation democratic, but Nature herself favors the cause of the people."[28] If Nature (so powerful it was capitalized) was the chief promoter of American democracy, war was its chief enemy. "All those who seek to destroy the liberties of a democratic nation ought to know," Tocqueville believed, "that war is the surest and the shortest means to accomplish it" by encouraging hierarchy and a strong central state.[29]

One could not separate these forces: Americans were democratic because they avoided war, and they avoided war because nature protected the country from external and internal threats. Nature shielded Americans from outside threats by placing the

country "in the midst of a wilderness." A "few thousand soldiers" sufficed. This was important because the army's hierarchical spirit and desire for power clashed with democratic values. Nature protected the country from internal threats by supplying bountiful natural resources. The availability of land created an "innumerable multitude" of middle-class property owners, who opposed revolution and war as threats to their property. Their numbers enabled them to quell agitation for violent change by the rich or the poor.[30]

So far so good in Tocqueville's land of Eden. But the garden had its snakes. Ironically, Tocqueville believed, democracy made war more severe as well as less frequent. Popular passion was one reason. "There are two things that a democratic people will always find very difficult," Tocqueville argued, "to begin a war and to end it." So long as wars were struggles among the nobility, the views of the people had little impact on leaders. But, in a democracy, once war had "roused the whole community from their peaceful occupations," the populace would throw toward war "the same passions that made them attach so much importance to the maintenance of peace." Similarly, wars among the nobility kept battles small by keeping armies small (because nobles had to pay professional soldiers). But, as Napoleon had shown in France, feudalism's downfall enabled nations to raise gigantic armies from the citizenry and conquer capital cities in a "single blow." Finally, the spread of democracy encouraged war over a wider geographic scale. Democratic countries shared "interests … opinions, and wants" so closely that "none can remain quiet when the others stir," Tocqueville argued. "Wars therefore become more rare, but when they break out, they spread over a larger field."[31]

Much of Tocqueville's analysis held true in the twentieth century. Democracies did find their interests intertwined, which helped give birth to the first two *world* wars. Once in a war, popu-

lar passion did soar. Patriotism (and the wartime power of the state) did enable the country to raise a large army that aimed to overthrow the enemy's ability to wage war entirely. The United States did have a hard time ending a war without "total victory" and "unconditional surrender," as the nation showed at the end of both world wars.

But another aspect of Tocqueville's analysis did not hold true. He, like many others, saw the control of nature as a civilian occupation and war as a military occupation. It was America's focus on gaining power through conquest of nature, rather than conquest of other people, that set it apart from undemocratic Europe. He made this point by comparing the United States and Russia in a passage worth quoting at length: "The American struggles against the obstacles that nature opposes to him; the adversaries of the Russian are men. The former combats the wilderness and savage life; the latter, civilization with all its arms. The conquests of the American are therefore gained by the plowshare; those of the Russian by the sword. The Anglo-American relies upon personal interest to accomplish his ends and gives free scope to the unguided strength and common sense of the people; the Russian centers all the authority of society in a single arm. The principal instrument of the former is freedom; of the latter, servitude. Their starting-point is different and their courses are not the same; yet each of them seems marked out by the will of Heaven to sway the destinies of half the globe."[32]

What Tocqueville did not foresee was that control of nature, including by civilians, could increase military power. The Industrial Revolution transformed nature into useful products on an unheard-of scale with astounding efficiency. In the same way that industrialization increased productivity of laborers in factories, so it increased productivity of soldiers on battlefields. In an industrial world, one could not calculate, as Clausewitz had, military power almost solely as a function of the number of soldiers.

One had to include natural resources and technology in the equation. These inclusions meant that not just the army could benefit from (and agitate for) war, as Tocqueville believed. Now civilians could benefit as well. The citizens who stood to benefit most were not individual pioneers chopping down trees, but industrialists who could transform nature quickly on a large scale. Because political power grew (partly) out of economic power, war could undermine democracy by shifting power not just from individuals to a large state, but from individuals to large private institutions – especially if those institutions worked closely with the army to advance the interests of both. Along with technology and institutions, ideas developed to control nature were useful in war. The formalized set of ideas known as science contributed insights useful in developing technology. Informal ideas about the moral and practical importance of controlling nature provided a set of common values the state could mobilize in efforts to control human enemies. The American focus on transforming nature was not proof against war or its concomitant challenge to democracy.

Nor did Tocqueville foresee that war could increase control of nature. War, even in another country, increased demand for agricultural and industrial products. Civilians responded by intensifying their transformation of nature into those products. Increased demand increased the market for more efficient technology, which stimulated invention, development, and marketing of new tools. As appreciation for the importance of science and technology in war grew, so did government efforts to mobilize these resources. The federal government did not wait for market forces to change the civilian economy; it intervened by creating and linking institutions, by expanding industry, agriculture, and science through direct funding and tax subsidies, and by hastening technology transfer through changes in intellectual property rights. Recognizing that nature, in the form of disease, threatened troop

strength (and manufacturing of war materiel) more than did combat, the federal government developed and applied new methods to control disease overseas and at home. It kept these methods secret so that disease would continue to cripple enemy soldiers, converting natural enemies into natural allies. It mobilized ideas about the moral and practical importance of war to encourage control of nature on a wider scale.

This book examines these processes, which helped transform the United States from the condition Tocqueville described in the nineteenth century to the one Dwight Eisenhower and Rachel Carson depicted in the early 1960s. (This is not to say that Tocqueville was precisely accurate at the time he was writing, nor that conditions had not changed by World War I. The United States waged wars in the nineteenth century too, and the United States did not have an even distribution of power among citizens. But Tocqueville's analysis was a reasonable rough description of the way Americans saw things on the eve of World War I.) By the time Eisenhower delivered his farewell address as president and Carson published *Silent Spring,* the United States had increased its industry, military, and civilian government to sizes that an Eisenhower Republican (Ike himself) and a Kennedy Democrat (Carson) both saw as threats to democracy and even survival.

The first two narrative chapters (2–3) of this book describe the impact of World War I on the United States. For the first couple years of the war, the United States participated without going to war by supplying the Allies with industrial and agricultural products. This participation changed the way Americans interacted with each other and with nature. The American chemical industry grew in size, expertise, profitability, and status. American scientists developed new chemicals to kill insect pests. Farmers applied more kinds of insecticides, in greater quantities, than ever before. Americans imbibed Allied propaganda, which drew on the American relationship with nature to frame American understand-

ing of the war. When the United States declared war, the changes already underway spread more widely through the country. The need to wage gas warfare forced the country to marry science and the military. This marriage increased commitment of military and civilian chemists to poison gas and created a new institution within the army, the Chemical Warfare Service. Gas research stimulated research on war gases as insecticides and ties between entomologists and chemical officers; it also increased the profile and activities of federal entomologists. The federal government mobilized public opinion through a large propaganda program that, among other strategies, tapped into ideas about nature to frame understanding of the war.

The next two chapters (4–5) focus on the aftermath of World War I. Chemical warfare advocates thought they had proven the power, efficiency, and humanity of poison gas on the battlefield. But they returned home to find their ideas and technology rejected by the army and the public alike. The Chemical Warfare Service survived a series of threats between the world wars by enlisting allies and lobbying Congress effectively. Part of its strategy was to transform its image by developing and publicizing civilian uses of gas, one of the most important of which was using war gases as insecticides. Because agriculture had long been seen as a morally uncontroversial civilian endeavor, this campaign enabled the Chemical Warfare Service to describe itself as the Chemical Peace Service waging "peaceful warfare." It also reinforced the service's ability to redefine chemical warfare as pest control. Civilian entomologists also entered the world of "peaceful warfare," albeit for opposite reasons. Fighting the image of insects (and thus entomology) as trivial, entomologists promoted the idea that human beings were engaged in a war for survival with insects. In cooperation with the armed forces, they adapted military weapons, notably airplanes (and to some extent poison gases), to agriculture. Chemical companies capitalized on the capital and expertise

gained in the war to grow and expand their work on insecticides, especially by searching for synthetic organic insecticides. American companies achieved limited success in this search by World War II. In the 1930s, some of these companies found themselves on the defensive when charged with profiting from (and even fomenting) warfare. Associations with chemical warfare reinforced the notion that these companies were "merchants of death."

The following four chapters (6–9) examine World War II and its aftermath. At home and overseas, the United States mobilized to wage "total war" on human and insect enemies. It linked military and civilian institutions, developed new chemical technology to control insects and people, and joined chemical warfare and pest control on rhetorical, institutional, and technological levels. These efforts paid off when the United States gained the ability to "annihilate" people and insects. Against civilians, the main weapons were incendiaries. Against insects, the main weapon was DDT. The stunning practical power of science demonstrated during the war led leaders to plan ways to apply the lessons of World War II to the postwar world. For academic scientists, this meant seeking to continue federal funding of science. For industrial scientists, it meant switching from military to civilian markets, including marketing the new wonder insecticide DDT. For government scientists, it meant trying safely to guide the blunt weapon that was DDT to civilian life. For military scientists, it meant maintaining links with civilian science and industry. At the end of the war, the ideas, technology, and institutional structures of the war entered civilian life roughly as planned. For the most part they were welcomed, though doubts swirled in some specialized circles.

Chapters 10–11 focus on the Cold War, an extended period of peaceful warfare punctuated by shooting wars. Against the Soviets and insects, the United States engaged in arms races by continually escalating the power of its chemical arsenals. For use against human enemies, the United States relied in battle on incendiaries.

It armed itself with a new nerve gas it had gained from Germany at the end of World War II, added a more powerful nerve gas (apparently derived from insecticide research) later in the decade, and researched psychochemicals that were to create bloodless warfare. Against insects, one family of insecticides after another lost their ability to kill insects as their targets evolved resistance. The army took the lead in trying to understand this process by organizing and funding research that civilian institutions would not otherwise have undertaken. Continued funding, sometimes with the help of intermediary institutions, accustomed civilian scientists to doing research for the armed forces while pursuing their own interests. Confident of the technology they had gained during and after World War II, chemical officers and federal entomologists promoted eradication of human and insect enemies to the American public in the latter 1950s. The strategy backfired as scientists and the public protested against chemical warfare and large pest eradication projects. The ability of scientific and technological elites in government and industry to develop and seemingly foist such measures on the public motivated two of the signal critiques of the Cold War distribution of power. Dwight Eisenhower left the presidency by criticizing the ideology, institutional relations, and technology of the "military-industrial complex." Rachel Carson catalyzed the modern environmental movement by making a parallel argument about chemical pest control.

The epilogue briefly describes events from 1962 to the end of the century, and it essays some lessons. The latter are not simple. We like to hear stories of progress or decline. An historian has termed them ascensionist and declensionist narratives, and dramatists call them comedies and tragedies.[33] In tales of progress, we learn of heroic individuals we can emulate and grand ideas we can follow. In tales of decline, we see cautionary tales that warn us off dangerous people and ideas. The narrative drive derives from our sense that we know where the tale is headed. Beware, for this tale

is both. The events described here made the world both a better place and a worse one. For some people insecticides and chemical weapons were blessings, for others they were curses, and for some they were both. The world gets both better and worse, and we have yet to exterminate either good or evil.