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Historical Precedence and Technical Requirements of Biological Weapons Use:

A Threat Assessment

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Abstract

The threat from biological weapons is assessed through both a comparative historical analysis of the patterns of biological weapons use and an assessment of the technological hurdles to proliferation and use that must be overcome. The history of biological weapons is studied to learn how agents have been acquired and what types of states and substate actors have used agents. Substate actors have generally been more willing than states to use pathogens and toxins and they have focused on those agents that are more readily available. There has been an increasing trend of bioterrorism incidents over the past century, but states and substate actors have struggled with one or more of the necessary technological steps. These steps include acquisition of a suitable agent, production of an appropriate quantity and form, and effective deployment. The technological hurdles associated with the steps present a real barrier to producing a high consequence event. However, the ever increasing technological sophistication of society continually lowers the barriers, resulting in a low but increasing probability of a high consequence bioterrorism event.

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Contents

1. INTRODUCTION 9

1.1 TERMS AND DEFINITIONS 10

1.1.1 Biological Weapons 10

1.1.2 Bioterrorism 11

1.1.3 Biocrimes 11

1.1.4 Diversion 12

1.1.5 High Consequence Pathogens and Toxins 12

1.1.6 High Consequence Event 12

1.1.6.1 Physical Damage 13

1.1.6.2 Economic Impact 13

1.1.6.3 Mass Casualties 13

1.1.6.4 Social Disintegration 13

1.1.6.5 Summary 14

2. HISTORY OF BIOLOGICAL WEAPONS 15

2.1 STATE PROGRAMS 15

2.1.1 State Biological Weapons Use 1914–72 15

2.1.1.1 World War I 15

2.1.1.2 The Inter War Years 17

2.1.1.3 World War II - 1972 22

2.1.1.4 The Biological and Toxins Weapons Convention 27

2.1.2 State BW Programs and Use After 1972 27

2.1.3 Revisiting the BWC *34*

2.1.4 Summary *35*

2.2 SUBSTATE ACTORS 36

2.2.1 Types of Substate Actors *37*

2.2.1.1 Social Revolutionaries 37

2.2.1.2 Nationalist-Separatists 38

2.2.1.3 Religious Groups 38

2.2.1.4 Single Issue Groups 38

2.2.1.5 Right-Wing Groups 39

2.2.1.6 Lone Actors 39

2.2.2 Bioterrorism Incidents *40*

2.2.3 Incidents of Possession *46*

2.2.4 Incidents of Attempted Acquisition *49*

2.2.5 The Special Case of Diversion *51*

2.2.5 Summary *53*

3. TECHNICAL HURDLES 55

3.1 ACQUISITION OF A VIRULENT PATHOGEN OR TOXIN 58

3.1.1 Availability *59*

3.1.2 Infectivity *60*

3.1.3 Pathogenicity *61*

3.1.4 Lethality *62*

3.1.5 Transmissibility *62*

3.1.6 Amplification *63*

3.1.7 Processing *63*

3.1.8 Available Countermeasures and/or Immunity *63*

3.1.9 Environmental Hardiness *64*

3.1.10 Ability to be Camouflaged *65*

3.2 PRODUCTION OF MATERIAL 65

3.3 PROCESSING OF MATERIAL 66

3.4 EMPLOYING A DELIVERY FORM AND DEVICE 67

3.4.1 Inhalation via Aerosolization *67*

3.4.2 Ingestion *69*

3.4.3 Percutaneous Inoculation *69*

3.4.4 Other Dissemination Methods *69*

3.4.5 Environmental Considerations *70*

3.5 OTHER FACTORS 70

3.6 SUMMARY 72

4. CONCLUSION 74

Nomenclature

ATCC	American Type Culture Collection
BW	Biological Weapons
BWC	Biological and Toxins Weapons Convention
CBM	Confidence Building Measure
CDC	Centers for Disease Control and Prevention
CW	Chemical Weapons
DA	Department of the Army
DoD	Department of Defense
FARC	Columbia's Revolutionary Armed Forces
FBI	Federal Bureau of Investigation
FMD	Foot and Mouth Disease
FSU	Former Soviet Union
HCPT	High Consequence Pathogens and Toxins
HHS	Department of Health and Human Services
IRA	Irish Republican Army
ISTC	International Science and Technology Center
MIIS	Monterey Institute for International Studies
MIRCEN	Microbiological Resource Centers
NBC	Nuclear-Biological-Chemical Triad
PFLP-GC	Palestinian Front for the Liberation of Palestine-General Command
PKK	Kurdistan Workers Party
spp	species not otherwise typed
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization
US	United States
USDA	United States Department of Agriculture
USG	United States Government
USAMRIID	United States Army Medical Research Institute of Infectious Diseases
USPS	United States Postal Service
VEREX	ad hoc group of governmental experts
WMD	Weapons of Mass Destruction

Historical Precedence and Technical Requirements of Biological Weapons Use: A Threat Assessment

1. Introduction

The concept of using pathogens and toxins in warfare is not new; documented use dates at least to the Middle Ages. However, the fall 2001 anthrax attacks have refocused attention on the issue. Prior to the attacks, biological weapons (BW) threat assessments often concluded either that there was no serious threat or that the threat was imminent and apocalyptic. The wide disparity of opinion is indicative of an ideological divide among the policy makers, academics, and biological weapons experts who conduct the threat assessments. The division falls along different methodological approaches used to assess the BW threat.

On one side of the debate are those who conduct their threat assessments based chiefly on the historical precedence of biological weapons research, development, and use.[1] These threat assessments inevitably conclude that the BW threat, particularly by terrorist groups, is both a low probability and a low consequence event. These assessments tend to view states as the only actors capable of a large-scale, mass casualty, bio-related event (including sponsoring acts of terrorism). Consequently, adherents to this perspective support multilateral initiatives to stem the state biological weapon threat.

On the other side of the debate are those who conduct threat assessments based largely on the scientific and technical skills and expertise needed to transform a pathogen or toxin into a biological weapon.[2]

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[1] For examples, see: (1) Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000. (2) Brian Jenkins, "Terrorism: Current and Long Term Threats," testimony before the Senate Armed Services Subcommittee on Emerging Threats. US Senate, November 2001. (3) Jonathan B. Tucker, *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Cambridge, MA: MIT Press, 2001. (4) Jonathan B. Tucker and Amy Sands, "An Unlikely Threat," *The Bulletin of the Atomic Scientists*, *55*, July/August 1999. (4); (5) John Parachini, "Combating Terrorism: Assessing the Threat of Biological Terrorism," testimony before the Subcommittee on National Security, Veterans Affairs, and International Relations, Committee on Government Reform, U.S. House of Representatives, October 2001. (6) David C. Rapoport, "Terrorism and Weapons of the Apocalypse," *National Security Studies Quarterly*, Summer 1999. (7) Elisa Harris, "Statement by Elisa Harris." Statement before the House Committee on Government Reform, November 15, 2001. http://www.house.gov/reform/min/pdfs/pdf_com/pdf_terrorism_bio_briefing_harris_test.pdf (8) Ehud Sprinzak, "The Great Superterrorism Scare," *Foreign Policy*, *112*; Fall 1998. (8) Marie Isabelle Chevrier, "The Threat of Chemical and Biological Terrorism is Exaggerated," *Weapons of Mass Destruction* (Jennifer Hurley, Ed.), Greenhaven Press, 1999.

[2] For examples, see: (1) Malcolm Dando, *The New Biological Weapons: Threat, Proliferation, and Control*. Boulder, CO: Lynn Rienner Publishers; 2001. (2) Kathleen C. Bailey, "Problems with Verifying a Ban on Biological Weapons," *Lawrence Livermore National Laboratory Director's Series on Proliferation, 3*; January 5, 1994. (3) Mark Wheelis, "Biotechnology and Biochemical Weapons," *The Nonproliferation Review. 9*(1), Spring 2002. (4) Steven Block, "Living Nightmares: Biological Threats Enabled by Molecular Biology," *The New Terror Facing the Threat of Biological and Chemical Weapons*, (Sidney D. Drell, Abraham D. Sofaer, and George D.

These threat assessments tend to conclude that the threat of biological weapons use is growing as a result of the increased availability of dual-use materials and technologies and that the threat of biological weapons represents a significant danger. Here, both state and substate actors are considered potential aggressors.

In order to provide a more comprehensive biological weapons threat assessment, this study uses both comparative historical analysis and technological assessment.[3] Following the delineation of the historical pattern of biological weapons use, the paper then examines the technical record and requirements for biological weapons proliferation and use. This secondary analysis looks specifically at the technical barriers to creating a mass casualty biological weapon and accompanying delivery system. Once again, differing methodologies have produced widely disparate conclusions, in this case regarding the technical difficulty of developing and deploying biological weapons. While issues of pathogenicity, lethality, transmission rates, and environmental degradation have hampered even well-funded state biological weapons programs, substate actors have been able to achieve some success with non-lethal pathogens and toxins. Consequently, examining the technical issues surrounding pathogen or toxin manipulation is as important as the historical record in understanding the nature of the biological weapons threat.

We believe this combined approach—which identifies incidents of biological weapons research, development, and use (at both the state and substate level), incidents of pathogen or toxin diversion, motivations for use, and technical difficulties associated with deploying a biological weapon—results in a more holistic threat assessment that can be used to develop a comprehensive strategy to counter the biological weapons threat.

1.1 Terms and Definitions

Whenever possible, this study relies on commonly used terms and standard definitions for the concepts associated with biological weapons research, development, and use. However, several concepts associated with aspects of biological weapons work have been poorly defined or are only now becoming part of the BW lexicon. Therefore, this section introduces and discusses each concept as it is used throughout the study.

1.1.1 Biological Weapons

A biological weapon is any pathogen or toxin used as a weapon. Biological weapons that use High Consequence Pathogens and Toxins (defined in Section 1.1.5) pose the greatest threat. High Consequence Pathogens and Toxins will include those agents that have been selected and/or manipulated in such a way

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Wilson, Eds.), Stanford, CA: Hoover Institution Press, 1999. (5) Raymond Zilinskas, "Assessing the Threat of Bioterrorism," Testimony before the Subcommittee on National Security, Veterans Affairs, and International Relations. US House of Representatives, October 20, 1999. (6) Joshua Lederberg (Ed.), *Biological Weapons: Limiting the Threat*, MIT Press; 1999. (7) Tara O'Toole and Thomas V. Ingelsby, "Facing the Biological Weapons Threat," *The Lancet*, February 10, 2001.

[3] Few open source studies adopt this approach. One notable exception is: Jean Pascal Zanders, "Assessing the Risk of Chemical and Biological Weapons Proliferation to Terrorists," *The Nonproliferation Review*. *6*(4), Fall 1999.

as to exhibit heightened infectivity, transmissibility, lethality, environmental hardiness, and/or result in a theoretical chimera agent.[4] However, simply possessing a pathogen or toxin does not necessarily equate to possessing a biological weapon. Several steps are necessary to develop and deploy a biological weapon. They are:

1. acquiring a virulent pathogen or toxin
2. producing material
3. potentially processing the material
   a. to resist environmental stressors
   b. to survive dissemination
   c. to increase the pathogens' or toxins' ability to invade a host organism (pathogenicity)
4. employing an appropriate delivery form and device
5. deploying the agent

These characteristics of a pathogen or toxin and the steps for successful deployment are discussed in greater detail in Section 3.

1.1.2 Bioterrorism

While there is no single accepted definition of bioterrorism, for the purposes of this study we rely on a modified version of the Federal Bureau of Investigation's (FBI) definition of terrorism:[5]

Bioterrorism is the unlawful use of viruses, bacteria, fungi, toxins, or other pathogenic material against a government, the civilian population, livestock, crops, or any segment thereof, in furtherance of political, social, and/or economic objectives.

1.1.3 Biocrimes

While all terrorist acts can be defined as criminal, not all criminal acts similar to terrorist acts are terrorism. For example, an individual might use a bomb either to injure or kill a spouse, or to destroy a target that he or she considers a representation of an enemy government, agency, or system. The former is a crime, the latter terrorism. Consequently, an act cannot be defined merely by the type of weapon used

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[4] A chimera is an agent that has been combined with another agent to increase any of the above characteristics. To date, no known biological weapons have been developed that are chimeras. In the future, however, advances in both microbiology and biotechnology make the possibility more likely.

[5] Terrorism, as defined by the FBI, is "the unlawful use of force of violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." http://www.access.gpo.gov/nara/cfr/waisidx_03/28cfr0_03.html It is important to note, however, that even within the US government definitions are not uniform. For example, the Department of State uses Title 22 of the United States Code, Section 2656f(d) for its definition. That statute defines terrorism as the premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine agents, usually intended to influence an audience (See Department of State, *Patterns of Global Terrorism*, 2001. (http://www.state.gov/documents/organization/10319.pdf).

(conventional, radiological, chemical, or biological) but, rather, by the intent of the actor.[6] For the purposes of this study, biocrimes will not be included in the analyses.

1.1.4 Diversion

Diversion can encompass several types of events, including the unauthorized or illicit procurement of biological material, the unauthorized interception of biological material in transport, or the theft of biological material from an authorized repository.

1.1.5 High Consequence Pathogens and Toxins

High Consequence Pathogens and Toxins (HCPT) are defined as pathogens and toxins, which are capable of severely affecting the US public health, safety, economy, and national security, or producing a high consequence event (defined in Section 1.1.6). The category includes pathogens and toxins that would most likely be targeted for diversion for use in bioterrorism or biological weapons proliferation. It is important to note that many pathogens that cause highly infectious disease would not necessarily be effective biological weapons. The US government's interpretation of HCPTs is defined as a list of select agents.[7] Additionally, a Centers for Disease Control and Prevention (CDC) Strategic Planning Workgroup met in 1999 to evaluate the public health consequences of some agents. They divided agents into three categories: A, B, and C agents; Category A agents were the highest concern from a public health perspective.[8]

1.1.6 High Consequence Event

A high consequence event is a concept that has been particularly difficult to define. It has been traditionally associated with injuries and/or deaths of individuals (mass casualties). However, there are several factors that should be considered when deciding whether an event is high consequence. This study focuses on four elements: (1) Physical Damage, (2) Economic Impact, (3) Mass Casualties, and (4) Social Disintegration.

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[6] Identifying intent of the individual(s) using a bioagent can be difficult. Without clear-cut evidence of intent (such as a confession or clear linkage to a group whose goals are well known) a certain amount of guesswork is involved. Wherever possible, multiple sources identifying intent are used; however, when multiple sources are not available, appropriate disclaimers will be provided.

[7] Federal Register, Rules and Regulations, Vol 240, No. 67, 42 CFR Part 73 (Department of Health and Human Services, Office of the Inspector General), December 13, 2002 p. 76895; Federal Register, Rules and Regulations, Vol 240, No. 67, 7 CFR Part 331, 9 CFR Part 121 (Department of Agriculture, Animal and Plant Health Inspection Service), December 13, 2002, p. 76921.

[8] "Public Health Assessment of Potential Biological Terrorism Agents," *Emerging Infectious Diseases*. 8(2) February 2002, p. 225-230.

1.1.6.1 Physical Damage

One possible way to define a high consequence event is by the extent of physical damage incurred. This includes both damage to structures (e.g., contamination) as well as disruption of various components of infrastructure (e.g., communications, transportation, and food and water distribution systems). Physical damage, if sufficiently extreme, can cause the number of injuries and/or deaths to continue to increase well after the actual event takes place.

1.1.6.2 Economic Impact

The economic impact must also be considered when determining whether an event is high consequence. As with the impact of physical damage, the full economic impact may not be realized until some time after the event has occurred. For example, while the fall 2001 anthrax attacks infected 22 individuals, and killed 5, the economic impact has yet to be calculated in terms of building decontamination, medical costs, the sustained disruption of postal services, and decreased tourism. Economic impacts are also incurred when biological weapons are directed against animals (e.g., livestock) and plants (e.g., crops).

1.1.6.3 Mass Casualties

Mass casualties represent the most traditional conception of a high consequence event, referring to the actual number injured or dead. Currently, the Department of Health and Human Services (HHS) defines a mass casualty event to include at least 1,000 injuries and/or deaths.[9] Under this definition alone, the fall 2001 US anthrax attacks would not be considered a high consequence event.

1.1.6.4 Social Disintegration

Social disintegration is the dissolution of the social contract made between citizens and their government. It represents the loss of trust by citizens in their government's ability to protect them. It also indicates a breakdown in the social rules and norms of behavior. This is fundamentally different than the "social panic" hypothesis which predicts that in the event of a large-scale crisis, human behavior will devolve into more primitive "survival of the fittest" strategies. While either outcome is possible following a biological weapons attack, the response of citizens to both the September 11, 2001 attacks and the fall 2001 anthrax attacks indicates that neither outcome has occurred. Of the four characteristics, social disintegration is the least predictable and most difficult to quantify.

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[9] The metropolitan medical response systems under the Department of Health and Human Services use 1,000 casualties (physical injuries or death) as a basis for their planning purposes. See US General Accounting Office, *Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks, GAO/NSIAD-99–163*, Washington, DC: U.S. General Accounting Office, 7, September 1999.

1.1.6.5 Summary

The number of casualties is traditionally the most important characteristic that the US government (USG) considers when assessing the biological weapons threat. Because of this, the other three characteristics (physical damage, economic impact, and social disintegration) are often not given appropriate weight in determining high consequence events. Further complicating the matter is the fact that while mass casualties have been defined with a threshold of 1,000 injured and/or killed,[10] no such threshold has been identified for either physical damage or economic impact. Finally, social disintegration is difficult to measure. While there may be characteristics that can be identified early in an attack (e.g., running from an attack site), long-term consequences to social order may not be readily identifiable and/or may be more difficult to predict than the other characteristics.

[10]Ibid.

2. History of Biological Weapons

The historical record of biological weapons development and use is complicated by conflicting reports, often unsupported by secondary documentation. In addition, numerous factors impede verification of alleged biological weapons attacks. Finally, biological weapons may be introduced during naturally occurring disease outbreaks;[11] thus, failing perpetrator self-attribution, some incidents may never be discovered. Despite these drawbacks, there are fairly well documented incidents of biological weapons use, procurement, and possession. This section examines the incidents of biological weapons use at both the state and non-state level. An analysis follows, with an emphasis on how the agents have been acquired and what type of states, groups, and/or individuals have used these agents.

2.1 State Programs

The concept of using disease as a tool of warfare is not new. Prior to the development of modern warfare—where states applied new scientific developments to produce tanks, machine guns, and aircraft—victory depended largely on the number of men fighting on each side; wars were typically wars of attrition, and the ability to incapacitate soldiers or disrupt supply lines could produce the decisive numerical advantage necessary for victory.[12] Some of the earliest reports of biological weapons use reflect this need to incapacitate or kill enemy combatants. For example, in the Middle Ages, cadavers infected with plague were catapulted over city walls. Later, in the American colonial period, the British handed out smallpox-infected blankets to Native Americans. [13] The dawning of the 20th Century brought the solidification of the nation-state and a new chapter in the history of biological weapons. States began to explore the role of biological weapons within the new realities of modern warfare.

2.1.1 State Biological Weapons Use 1914–72

2.1.1.1 World War I

The First World War was a period of transition between the pre-modern and modern ages of warfare. The war saw cavalries but also trench warfare, the beginning of air and tank use, and multilateral involvement. Both France and Germany had active biological weapons programs during the war.

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[11] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin, and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

[12] Mark Wheelis, "Biological Warfare Before 1914," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[13] Jonathan B. Tucker, *Scourge: The Once and Future Threat of Smallpox*, Atlantic Monthly Press, 2001.

The German biological weapons program is best described as a sabotage program. Its aim was to undermine the enemy's economic capacity to wage war. The program appears to have been independent of civilian oversight and was undertaken despite the General Staff's position that biological warfare was illegal. Notwithstanding, there was widespread agreement that anti-human pathogens should not be developed. Consequently, the German program considered only anti-animal and anti-crop pathogens;[14,15,16] there is no evidence that Germany attempted to infect humans with any type of biological agent. Germany's main targets were neutral nations that supplied the Allied Powers. The most extensive efforts were directed against the US (prior to its entry into World War I), although Argentina, Romania, Norway, and possibly Spain were also targeted.[17,18]

The German sabotage program relied on both German and non-German operatives, but appears to have been directed by diplomatic and consular corps officials within the target nations.[19] Pathogens used included glanders and anthrax.[20,21] Dissemination methods were crude and involved infecting food sources for animals, brushing bacteria on the noses of animals, and the direct "jabbing" of infected implements into animals to be shipped to Europe for use by the Allied Powers. The overall success of these efforts is difficult to assess. There were epidemics of glanders among livestock controlled by the

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[14] The German anti-crop program appears to have involved chemical sabotage only. Consequently, it will not be discussed.

[15] Erhard Geissler, "Biological Warfare Activities in Germany, 1923-1945," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[16] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin, and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Associatio, 278*(5), August 6, 1997.

[17] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*, Center for Counterproliferation Research, Washington, D.C.: National Defense University, August 1998 (Revised February 2001).

[18] J. Witcover, *Sabotage at Black Torn: Imperial Germany's Secret War in America, 1914–1917*, Chapel Hill, NC: Algonquin Books of Chapel Hill, 1989.

[19] Ibid.

[20] Milton Leitenberg. "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000.

[21] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*. Center for Counterproliferation Research, Washington, D.C., National Defense University, August 1998 (Revised February 2001).

Allied Powers in Europe; however, these attempts at sabotage—which may or may not have been caused by intentional German acts—did not result in German victory.[22,23]

The historical record suggests that French biological weapons program—like its German counterpart—was directed against crops and animals. As in the German program, glanders was used to infect livestock. However, some reports claim that the French used their prisoners of war in Germany as test subjects. According to such accounts, the French assembled parcels filled with various agents they would later use to infect livestock, and shipped them to the German prisoners.[24]

There is no other evidence of official state programs during World War I. Additionally, it is important to note that there is considerably more documentation confirming that Germany had a formal program than there is for France.

2.1.1.2 The Inter War Years

Despite Germany's use of biological weapons during the First World War, the Treaty of Versailles—which specifically prohibited the use of chemical weapons—did not mention biological weapons. This oversight may have been the result of one or more factors, including: 1) the German program was one of sabotage only; 2) humans were specifically excluded as targets of the German program; or, 3) the drafters of the Treaty were unaware of the nature or extent of the German program. However, the Geneva Protocol of 1925, which entered into force in 1928, addressed the use of biological weapons; but it did not provide a comprehensive solution to the threat. This Protocol (*The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare*) prohibited the use of biological weapons during war, but did not outlaw continued research and development.[25] In addition, the Protocol also allowed many nations to retain the right of retaliation, and lacked a means of enforcing compliance.[26] Consequently, after WWI both Germany and France continued their biological weapons research and development, and many other nations began programs, including

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[22] Erhard Geissler. "Biological Warfare Activities in Germany, 1923-1945." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[23] Martin Hugh-Jones, "Wickham Steed and German Biological Warfare Research," *Intelligence and National Security. 7*(4), 1992.

[24] Olivier Lepick, "French Activities Related to Biological Warfare, 1919–1945." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[25] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin, and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

[26] Erhard Geissler, *Biological and Toxin Weapons Today,* New York, NY,Oxford University Press Inc., 1986.

Canada, Great Britain, and the Soviet Union.[27] The US and Japan also began programs; however, neither nation ratified the Protocol during this time.

Although many foreign powers assumed that Germany had an active and advanced biological weapons program during the inter war years, this was not the case. Although Germany did pursue rearmament, despite prohibitions following World War I, German biological weapons efforts were sporadic at best. Indeed, Germany's offensive program may have been undertaken solely in response to suppositions that France and the USSR were interested in developing their own BW programs. The evidence suggests that Germany did not pursue formal biological weapons research during this period (formal research did not begin until after the outbreak of the Second World War, discussed in section 2.1.1.3), and some sources indicate that the inter war research that was conducted related to the potato beetle.[28,29]

As with the German biological weapons program during World War I, the documentation of the French program during the inter war years is sporadic. Much of the documentation was destroyed in 1940 to prevent it from falling into the hands of the Germans. Nonetheless, enough information remains to outline the post-World War I French program, which seems to have begun in 1921. The impetus for the program was based on two convictions: first, a German biological weapons program existed and; second, Germany would never give up biological weapons research and development. As such, the French program was defensive in nature. Using information from the Trillat Report,[30] the French concluded that the Germans had intended to spread infectious disease along the front lines during World War I and that this research had continued. Additionally, the report asserted that biological weapons had specific—and desirable—military characteristics including delayed effects and the ability to infect only a small area; the disease would then spread through human and/or animal contact or through the air and/or water. The report identified specific defensive mechanisms, including vaccination, gas masks, and release of antiseptic clouds.[31]

In the early 1920s, France began to conduct experiments that examined whether pathogens could be effectively delivered by explosive devices. Animal experiments during this time used *Salmonella typhi*, *Streptococcus pneumoniae*, *Vibreo cholerae*, and *Micrococcus prodigious*. However, the program stalled

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[27] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin, and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

[28] Erhard Geissler, "Biological Warfare Activities in Germany, 1923–1945." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[29] Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000.

[30] Andre Trillat, Trillat Report, Director of Laboratoire annexe des etudes chimiques de la Marine (Naval Chemical Research Laboratory).

[31] Olivier Lepick, "French Activities Related to Biological Warfare, 1919–1945," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

between 1927 and 1934. The reason for this absence of research is not clear; it may be that France intended to abide by the prohibitions of the Geneva Protocol and/or was limited by financial constraints. But when Germany withdrew from that Protocol and tensions began to increase across Europe, France restarted its biological weapons program and began a cooperative Anglo-French program. Throughout the period, France's overall biological weapons policy appears to have been one of defense.[32]

Japan's biological weapons program began at the end of World War I with the creation of Unit 731. This unit began to conduct experiments on a variety of agents including anthrax, *Shigella* spp., *Vibreo cholerae*, *Salmonella* spp., and *Yersinia pestis*.[33] Because it conducted human experiments, Japan's program was fundamentally different than other programs of the period. Initially, Japan used prisoners for testing.[34] The experiments were carried out in Manchukuo (Manchuria), a region in China commonly afflicted with endemic outbreaks of diseases such as pneumonic plague and cholera. Consequently, the Japanese biological weapons program could be tested while "hiding" amidst naturally occurring diseases. Interestingly, Japan's conquest of Manchukuo led to a League of Nations' investigation under the Lytton Commission in 1931 that itself became victim to an alleged attempt by Japan to infect members of the commission with cholera. There were no reported illnesses.[35] Throughout the period, Japan's program also included defensive research designed to counter suspected biological weapons development by the USSR and China.[36]

In contrast to other nations, Japan did not hesitate to use biological weapons. This may be due, in part, to the fact that Japan was not a party to the Geneva Protocol and therefore not bound by the prohibition on wartime biological weapons use. Another possible reason for Japan's use of biological weapons is more pragmatic: the Japanese believed that they would gain a strategic advantage over their adversaries by developing and acquiring the ability to deploy biological weapons.

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[32] Ibid.

[33] Sheldon H. Harris," Japanese Biological Warfare Research on Humans: A Case Study of Microbiology and Ethics," *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, Raymond A. Zelinskas (Ed.), New York, New York Academy of Sciences, 1992.

[34] Tom Mangold and Jeff Goldberg, *Plague Wars: The Terrifying Reality of Biological Warfare*, New York, NY: St. Martin's Press 1999.

[34] Ibid.

[35] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*, Center for Counterproliferation Resesarch, Washington, D.C., National Defense University, August 1998 (Revised February 2001).

[36] Sheldon Harris, "The Japanese Biological Warfare Programme: An Overview." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

Indeed, Japan used biological weapons extensively during World War II (discussed in Section 2.1.1.3).[37] The number of casualties of Japan's program during the inter war years is estimated to be at least 10,000.[38,39] In the past, Japan had denied both developing a biological weapons program and deploying biological weapons against humans. However, in a 2002 court ruling concerning reparations for Chinese victims of these attacks, Japan admitted using biological weapons both before and after World War II against Chinese citizens—killing perhaps thousands.[40]

The defeat of Imperial Russia in World War I, particularly the thousands of casualties suffered on the Eastern front, influenced the initial development of the Soviet military. Determined to not endure such a defeat again, the Soviet Union began to create a modern military with all manner of armaments at its disposal. While the impetus was originally to develop chemical weapons, it quickly evolved to include the biological weapons as well. However, it remains unclear what priority biological weapons research and development had in the larger military modernization effort.[41] During this period, the Soviets voiced reservations to the Geneva Protocol, maintaining that the USSR would only be bound by the Geneva Protocol in relation to other states that abided by it. Essentially, the Russians reserved the right to violate the Protocol under two conditions. The Russians reserved the right to use biological weapons during wartime, against (1) any state not party to the Protocol and (2) any state in violation of the Protocol. These reservations responded to two fundamental weakness of the Protocol—the fact that it did not bind all states and the fact that it lacked a means of enforcement.

Although Russia suffered thousands of deaths at the hands of the Germans during World War I, USSR and Germany initially entered into a cooperative research agreement on chemical agents. However, Germany terminated this agreement in 1933, leaving the USSR with no reliable intelligence on German weapons proliferation. Subsequently, the USSR began to believe that Germany was developing a biological weapons program. The Soviets were equally suspicious about British biological weapons development. These fears spurred on the development of the Soviet program.

The Soviet BW program evolved under military control and direction. After conducting experiments with anthrax and botulinum toxin, the military argued that biological weapons were feasible. Similar to the

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[37] Ibid.

[38] Japanese prison camps of this time were particularly brutal. Therefore, it should be noted that this estimate does not appear to separate the effects of biological weapons experimentation from the environmental effects of imprisonment.

[39] Sheldon H. Harris, "Japanese Biological Warfare Research on Humans: A Case Study of Microbiology and Ethics," *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, Raymond A. Zelinskas (Ed.), New York, New York Academy of Sciences, 1992.

[40] Jonathan Watts, "Belatedly, Japan Admits Use of Germ Warfare." *The Los Angeles Times*, August 28, 2002. http://www.csmonitor.com/2002/0828/p07s01-woap.html

[41] Valentin Bojtzov and Erhard Geissler. 1999. "Military Biology in the USSR, 1920-1945." In, *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*. Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press.

authors of the Trillat Report in France, Soviet policy-makers concluded that bombs could effectively deliver pathogens to enemy territory. As a result, the USSR decided to expand the scope of research to include both offensive and defensive elements. The Soviets pursued the investigation of vaccines, decontamination methods, and protective clothing as BW countermeasures. Early offensive research focused on a variety of pathogens, including *Bacillus anthracis*, *Clostridium botulinum*, *Yersinia pestis*, *Mycobacterium tuberculosis*. Field tests, including open-air dissemination of selected agents, were conducted on animals at numerous sites in Kazakhstan and Uzbekistan. Eventually, Vozrozhdeniya Island became a primary biological weapons testing ground.[42]

During this inter war period, the Soviet biological weapons program suffered several set backs including poor training among its scientists, a civilian population that was already suffering from frequent outbreaks of endemic disease, and the Politburo's purges in which scientists and military officers were frequently targeted.[43] However, the Soviet program, while not particularly advanced during the inter war period, would eventually evolve into the most comprehensive biological weapons program in the world.

The British biological weapons program began as a defensive program in 1936. It evolved into an offensive and defensive program in the 1940s and 1950s, and returned to a defensive program in the 1950s. Although the Geneva Protocol had been ratified by the United Kingdom (UK), the British reserved the right to violate the Protocol under two conditions. Just as the Russians had done, the British reserved the right to use biological weapons during wartime, against (1) any state not party to the Protocol and (2) any state in violation of the Protocol.[44]

Britain's rationale for developing biological weapons—as was often the case in this period—rested partly on concerns that other nations—most notably, Germany and the USSR—had biological weapons programs.[45] During the inter war years, the British program—centered at Porton Down—focused primarily on countermeasures to be employed against biological weapons, including vaccines and various remedies for both human and animal targets.[46] The British program continued to evolve and advance during World War II (discussed in section 2.1.1.3).[47]

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[42] Ibid.

[43] V. N. Soyfer, *Lysenko and the Tragedy of Soviet Science*, New Brunswick, Rutgers University Press, 1994.

[44] Gradon B. Carter, *Chemical and Biological Defence at Porton Down*, London, The Stationary Office, 2000.

[45] Gordon Carter and Brian Balmer, "Chemical and Biological Warfare and Defence, 1945-1990. *Cold War, Hot Science.* Robert Bud and Philip Gummett (Eds.), Amsterdam, Harwood Academic Publishers, 1999.

[46] Gradon B. Carter and Graham S. Pearson, "British Biological Warfare and Biological Defence, 1925–45." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[47] Peter Hammond and Gradon Carter, *From Biological Warfare to Healthcare: Porton Down 1940–2000.* Great Britain: Antony Rowe, Ltd., 2002.

Canada's biological weapons program was largely directed towards assisting the American and British programs. Similar to many other nations, Canada had become increasingly concerned that such programs were being developed by other nations—particularly Germany and Italy. The Canadian biological weapons program, which was closely linked to its chemical weapons program, did not reach its apex until World War II (discussed in section 2.1.1.3).[48]

The US—like Japan—was not a party to the Geneva Protocol.[49] As early as 1926, the Chief of the US Chemical Warfare Service concluded that there was no effective method for the use of "germs" in warfare. This belief was strengthened by a 1933 Army Medical Corps article, which claimed successful dissemination of a BW agent would prove extremely difficult. The US opinion began to change in 1939, when a Japanese Army doctor attempted unsuccessfully to secure a strain of yellow fever from the Rockefeller Institute for Medical Research. Soon, the US had other reasons for concern. Between 1940 and 1941, scattered reports that Japan was using biological weapons in its war with China began to circulate. Additionally, in 1941 Swiss reports claimed that Germany was hiding experiments with botulinum toxin in Paris. Although some US officials were still skeptical about the need for a biological weapons program, by 1942 the War Bureau of Consultants concluded that warfare using biological weapons was feasible and posed a threat to US national security. Full program development took place during the Second World War (discussed in section 2.1.1.3).[50]

2.1.1.3 World War II - 1972

The biological weapons programs of the inter-war period continued throughout World War II. Among German intelligence had evaluated the Canadian, British, US, and Soviet programs, and were able to gain information on dissemination techniques after the fall of France in 1940. In addition, several Soviet deserters provided Germany with information about the Soviet program, leading Germany to conclude that the USSR had an advanced program that encompassed as many as eight facilities and test sites. Germany also believed that the USSR was experimenting with a number of agents, including those that cause anthrax, glanders, and foot-and-mouth disease (FMD). Similarly, Germany determined that the UK was working with anthrax, dysentery, glanders, and plague. German intelligence reports had also reached similar conclusions about Canadian research. Finally, Germany gained information about the US program in Edgewood Arsenal (Maryland) and Pine Bluff (Arkansas), indicating that anthrax and FMD, among others, were being studied and tested.

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[48] Donald Avery, "Canadian Biological and Toxin Warfare, Research, Development and Planning, 1925–1945, *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[49] Although the US signed the Geneva Protocol, the Senate did not ratify it at that time, and the Protocol was subsequently withdrawn from further consideration. The Protocol was not submitted for ratification until 1969 when President Nixon submitted it to the US Senate.

[50] John Ellis van Courtland Moon, "US Biological Warfare Planning and Preparedness: The Dilemmas of Policy." *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*. Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

Despite these numerous intelligence reports, Hitler reaffirmed his opposition to biological warfare— even as a tool of retaliation.[51] Instead, Hitler directed research towards defensive measures in the event of a BW attack by an Allied Power. The Nazis performed experiments on prisoners in their concentration camps. Prisoners were infected with *Rickettsia prowazekii*, *Rickettsia mooseri*, the Hepatitis A virus, and *Plasmodia* spp. Experiments were done primarily to aid in the development of preventive vaccines, and consequently, German officials believed that their biological weapons program was entirely defensive in nature.[52] While the possibility of offensive research cannot be excluded, ultimately Germany remained compliant with the prohibition of biological weapons use during war as stated in the Geneva Protocol.[53]

The Japanese biological weapons program also advanced during the Second World War. Japan had already conducted experiments on human targets prior to the outbreak of war. Japan continued these experiments and, in 1939, extended them to wartime targets.[54,55] Because these experiments occurred both before and during World War II, actual casualties during wartime are difficult to estimate; however, Japan has admitted to casualties numbering in the thousands.[56] Japan employed a variety of techniques to spread biological weapons agents including allowing fleas to feast on plague-infected rats prior to releasing them from aircraft over Chinese cities.[57] The allied occupation of Japan ended the state biological weapons program in that country.

The Soviet biological weapons program started as early as 1928. Control of the program transferred to the OGPU[58] (the state political police and precursor to the KGB[59]) in 1933, and the program continued

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[51] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective." *The Journal of the American Medical Associatio,. 278*(5)., August 6, 1997

[52] Ibid.

[53] *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945,* Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[54] Tom Mangold and Jeff Goldberg, *Plague Wars: The Terrifying Reality of Biological Warfare*, New York, NY: St. Martin's Press, 1999.

[55] Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000.

[56] Jonathan Watts, "Belatedly, Japan Admits Use of Germ Warfare," *The Los Angeles Times*, August 28, 2002. http://www.csmonitor.com/2002/0828/p07s01-woap.html

[57] Sheldon H. Harris, "Japanese Biological Warfare Research on Humans: A Case Study of Microbiology and Ethics," *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, Raymond A. Zelinskas (Ed.), New York: New York Academy of Sciences, 1992.

[58]Ob"edinennoe gosudarstvennoe politicheskoe upravlenie (OGPU) or Unified State Political Directorate

[59] Komitet gosudarstvennoi bezopasnosti (KGB) or Committee of State Security

throughout World War II. Following the 1941 publication of an article in *Informatsionni Sbornick* (a semi-official government bulletin) detailing biological weapons work in other nations, Soviet officials became alarmed at their nation's general lack of preparedness against a biological weapons attack. Five months later, German forces mounted an invasion of the USSR. Some scholars have suggested that part of the acceleration of the Soviet program included experiments on prisoners near Ulan Bator (Mongolia), in the prisons of Leningrad, in the White Sea off Kola Peninsula, and on one of the Solovki Islands. These human experiments may have been the cause of a plague epidemic in Mongolia resulting in 3,000 to 5,000 deaths following the escape of a prisoner who had been experimented on.[60] However the priority placed on biological weapons development within the larger context of military operations is unknown.

Of particular interest is an allegation that the Soviet army used biological weapons against the German army in 1942. That year, the Soviet BW program relocated to Kirov (560 miles NW of Moscow) to escape advancing German troops. During the 1942 battle of Stalingrad, tularemia infected German army troops in southern Russia. That outbreak eventually crossed battle lines and befell Soviet troops as well. In addition, in 1943 an outbreak of Q fever was reported in the Crimea. Significantly, both diseases were under research by the Soviets for possible biological weapons application. While suspicious, these incidents have not been confirmed as biological weapons use.[61]

The American, British, and Canadian biological weapons programs cooperated closely with one another during the second World War.[62] The American program started in earnest approximately seven months after the attack against Pearl Harbor in 1942. The program was under the direction of the War Reserve Service and included a research and development facility at Fort Detrick, MD—then known as Camp Detrick—and testing facilities in Mississippi and Utah. The program also included a production facility in Terre Haute, Indiana.[63] The existence of the US biological weapons program was not public knowledge and came about partially because the standard prohibitions against biological warfare were believed to be no longer applicable based on the evolution of World War II. Additionally, American policy makers believed that the Axis Powers were capable of ruthless implementation of their wartime objectives, a sobering conclusion, given numerous intelligence reports indicating their biological weapons capabilities were far more advanced than previously believed.

As a result, the US began a defensive biological weapons program that soon turned to offensive research. The program culminated with the development of what officials considered the most promising biological weapons: anti-plant agents. Research focused on developing these agents for use against isolated Japanese

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[60] Valentin Bojtzov and Erhard Geissler, "Military Biology in the USSR, 1920-1945," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[61] Kenneth Alibek, *Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World – Told from Inside by the Man Who Ran It*, New York, NY: Random House, 1999.

[62] Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents." Center for International and Security Studies, University of Maryland, September 2000.

[63] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

garrisons, which relied on their own gardens for food. Additional planning was also undertaken to investigate anti-crop agents for use against the Japanese mainland. These agents were considered ideal: they attacked a multitude of plants at all levels of development and were not vulnerable to climatic conditions. In addition, they produced no adverse effects on humans. [64] However, the American program did not limit itself to anti-plant agents. The US also conducted research on *Bacillus anthracis*, and *Brucella suis*, among others.[65]

After WWII, the production facility in Indiana was closed. However, the US opened a new facility in Pine Bluff, Arkansas, reflecting the expansion of the program during the Korean War (1950-1953). It was at this time that the US's technological advances allowed for large-scale fermentation and weaponization of pathogens and toxins. In addition, the US also conducted research to develop medical countermeasures to protect US troops from a BW attack.[66]

During the 1960s, the US program expanded its arsenal of biological weapons to include anthrax, botulinum toxin, tularemia, brucellosis, Q Fever, Staphylococcal enterotoxin B, Venezuelan equine encephalitis, Rice Blast, Rye Stem Rust, and Wheat Stem Rust.[67] The US offensive program was officially terminated by President Nixon in 1969 in anticipation of the US's entry into compliance with the Biological Weapons and Toxins Convention. The US also adopted a "No First Use" policy in relation to biological weapons.[68]

The British biological weapons program concentrated on anthrax and botulinum toxin.[69] The work on anthrax involved various dissemination techniques, including possible aerosolization. In 1942, British researchers from Porton Down converged on Scotland's Gruinard Island to conduct tests on the feasibility of anthrax dissemination from traditional bombs. The experiments—conducted on sheep—confirmed the feasibility of using anthrax from high-flying bombings. The UK also developed "cattle cakes" with anthrax as part of an anti-livestock program. These cakes contained *Bacillus anthracis* spores nestled between various crop products used in livestock feed. However, the UK policy dictated that the cakes be

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[64] John Ellis van Courtland Moon, "US Biological Warfare Planning and Preparedness: The Dilemmas of Policy," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[65] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin and Edward M. Eitzen Jr. "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

[66] Ibid.

[67] US Department of the Army, *US Army Activity in the US Biological Warfare Programs*, Washington, DC: US Department of the Army, February 24, 1977.

[68] George W. Christopher, Theodore J. Cieslak, Julie A. Pavlin and Edward M. Eitzen Jr., "Biological Warfare: A Historical Perspective," *The Journal of the American Medical Association, 278*(5), August 6, 1997.

[69] Gradon Carter and Brian Balmer, "Chemical and Biological Warfare and Defence, 1945-1990," *Cold War, Hot Sciene*, Robert Bud and Philip Gummett (Eds.), Amsterdam: Harwood Academic Publishers, 1999.

deployed only in retaliation against a German biological weapons attack. In the end, all but a few of the approximately five million cattle cakes were destroyed after World War II.[70,71] Ultimately, despite the extensive testing, Britain never deployed biological weapons against the Axis Powers.

After the second World War, the UK expanded its biological weapon research to include other agents such as tularemia, brucellosis, plague, and Venezuelan equine encephalitis. These agents were tested at sea using a variety of dissemination devices. The tests ended in 1955 and, in 1958, the Chiefs of Staff stated that neither biological nor chemical weapons had strategic value. By this time, the UK had informed its partners, Canada and the US, that the UK would only engage in defensive BW research. [72]

The Canadian biological weapons research facilities were developed at Goss Isle and Suffield during the war. Initially, Canadian officials feared the consequences of possible sabotage against its population. Of particular concern was the impact of an outbreak of either bubonic plague or Rinderpest. Canada began its collaboration with the US by sharing its extensive work on *Aegis aegypti*, a species of mosquito that is the vector for both yellow fever and malaria. In return, Canada was given access to US work on botulinum toxin, malaria, plague, typhus, and others. In 1941, Canadian, American, and British scientists met in Ottawa to discuss the nature of the biological weapons threat and, more specifically, which pathogens were most likely to be used by Germany and Japan. Formal cooperation between the three nations began in 1942, including collaboration with Britain's anthrax program. Additionally, an initiative to develop a Rinderpest vaccine was started. The Canadian-US research collaboration expanded in plague, brucellosis, and botulinum toxin, emphasizing the use of flies as vectors. Continued collaboration resulted in the development of an especially lethal strain of botulinum toxin. Despite their coordinated efforts, the US, UK, and Canada theoretically could only deploy anthrax as a weapon by the end of the war. Canada continued its partnership with the US and UK after World War II and through the early years of the Cold War.[73]

The end of World War II did not result in a new international treaty prohibiting the use of biological weapons. Instead, the Geneva Protocol was viewed as the continuing binding agreement among states parties. Consequently, many of the nations engaged in research during the war continued while other

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[70] Gradon B. Carter and Graham S. Pearson, "British Biological Warfare and Biological Defence, 1925-45," *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*. Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

[71]Richard J. Manchee, Malcolm G. Broster, Anthoy J. Stagg, and Stephen E. Hibbs, "Formaldehyde Solution Effectively Inactivates Spores of *Bacillus anthracis* on the Scottish Island of Gruinard," *Applied and Environmental Microbiology*, *60*(11), 1994.

[72] Gradon Carter and Brian Balmer. "Chemical and Biological Warfare and Defence, 1945-1990." *Cold War, Hot Science*, Robert Bud and Philip Gummett (Eds.), Amsterdam: Harwood Academic Publishers, 1999.

[73] Donald Avery "Canadian Biological and Toxin Warfare Research, Development and Planning, 1925-45," In, *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon (Eds), Oxford University Press, 1999.

nations initiated BW research. For instance, Israel began in 1948 to court scientists who could either kill or cure the masses.[74]

2.1.1.4 The Biological and Toxins Weapons Convention

Following the destructive use of chemical weapons on the battlefields of WWI, the international community took a major step forward in discouraging deployment of biological and chemical weapons by signing the *Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of Warfare*. Although the Geneva Protocol bans state use of chemical and biological weapons during times of war, it does not address the use of biological weapons in internal or civil conflicts. Further, the Geneva Protocol places no restrictions on the production, stockpiling, research, or testing of either chemical or biological weapons. The recognized limitations of the *Geneva Protocol* led to the drafting of the more comprehensive *Convention of the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction*, otherwise known as the Biological Weapons Convention (BWC).

The BWC opened for signature in 1972 and entered into force in 1975 after 19 countries, along with the three depository nations – the US, UK, and USSR – ratified the text and provisions. Currently, 146 countries are party to the treaty. These Member States meet for Review Conferences every five years to discuss strategies to strengthen the treaty.

The BWC was the first multilateral treaty to ban the production, stockpiling, acquisition, and effective use of an entire class of weapons. The BWC also prohibits Member States from transferring biological weapons (either directly or indirectly) or assisting or encouraging any state, group of states, or international organization, to fabricate or expand biological weapons program activities. The Convention requires States Parties with existing biological weapons programs to divert all illicit program activities towards legitimate purposes within nine months of their accession to the treaty.

Fulfilling the prohibitions of the Convention has proved to be exceedingly difficult due in large part to the BWC (1) lacking universality and (2) not including effective verification or enforcement mechanisms to guarantee compliance with the treaty provisions.[75]

2.1.2 State BW Programs and Use After 1972

Although many nations signed and ratified the BWC, officially discontinued all offensive biological weapons research and development, and declared any existing programs dismantled, biological weapons proliferation continued. Though the US stopped all offensive biological weapons work in 1969 and entered into the BWC in good faith, not all states were so inclined. Some states did not sign the BWC.

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[74] Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000.

[75] Reynolds M. Salerno and Daniel P. Estes, "National Legislative Measures to Prevent the Proliferation of Biological Weapons." Prepared for: National Nuclear Security Administration Office of Nonproliferation Policy (NA-241) U.S. Department of Energy (Sand No. 2003 – 4285), September 2003.

Others became signatories, yet retained prohibited programs. The Soviet Union maintained the most extensive of these illegal, clandestine programs.

After signing and ratifying the BWC, the USSR accelerated its offensive biological weapons program, which is believed to be the world's most comprehensive.[76,77] Although a signatory to the BWC, the Soviet Union continued research, development, and production of weaponized agents. The publication of *Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World–Told from Inside by the Man Who Ran It* in 1999 by Ken Alibek, a top official in the Soviet biological weapons program and defector to the US, confirmed that the Russians researched and weaponized a wide array of pathogens. *Biohazard*, as well as USG debriefings with Alibek himself, are cited as primary sources of information in the Office of the US Secretary of Defense's *Proliferation: Threat and Response*, released in January 2001.[78,79]

The Soviet biological weapons program was extensive, comprising a range of institutions under different ministries and approximately 50 ostensibly commercial facilities that were collectively known as Biopreparat. In addition, the Ministries of Agriculture and Public Health, as well as the KGB, the Soviet Academy of Sciences and the chemical industry were part of the program. At least four of these biological weapons institutes were under former Soviet military control and, to date, the US has not received access to these four institutes. An estimated 15,000 senior weapons scientists were involved in the program.[80,81,82] With the collapse of the Soviet Union, new nations such as Russia, Kazakhstan, Belarus, and Uzbekistan inherited an infrastructure capable of producing biological weapons.

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[76] C. J. Davis, "Nuclear Blindness: An Overview of the Biological Weapons Programs of the Former Soviet Union and Iraq," *Emerging Infectious Diseases*, *5*, 1999.

[77] Gulbarshyn Bozheyeva, Yerlan Kunakbayev, and Dastan Yeleukenov, "Former Soviet Biological Weapons Facilities in Kazakhstan: Past, Present, and Future," Center for Nonproliferation Studies, Monterey Institute of International Studies, Occasional Paper No. 1, 1999.

[78] Office of the Secretary of Defense, *Proliferation: Threat and Response*, US Department of Defense, January 2001. http://www.defenselink.mil.

[79] Sergei Popov, a former top scientist in the Soviet biological weapons program, who defected in 1992 (see http://www.pbs.org/wgbh/nova/bioterror/biow_popov.html), and the memoirs of Igor Domaradsky have confirmed many of Alibek's claims.

[80] "Biological Weapons: Efforts to Reduce Former Soviet Threat Offers Benefits, Poses New Risks," Report to Congressional Requesters: US General Accounting Office, April 2000.

[81] Amy E. Smithson, "Toxic Archipelago: Preventing Proliferation from the Former Soviet Chemical and Biological Weapons Complexes," The Henry L. Stimson Center, Report No. 32, 1999.

[82] "Biological Weapons: Efforts to Reduce Former Soviet Threat Offers Benefits, Poses New Risks," Report to Congressional Requesters: US General Accounting Office, April 2000.

The Soviet biological weapons program was not publicly confirmed until 1992—after the collapse of the USSR. Officials in the West had long suspected its existence, especially following an accidental release of weaponized anthrax from a Russian production facility. In April 1979, a biological weapons facility in Sverdlovsk, now Yekatarinburg, accidentally released 100 grams of highly processed, aerosolized *Bacillus anthracis* spores. The official explanation of the illnesses caused by the incident was that the infected individuals had consumed "tainted meat." While the exact number of fatalities resulting from this incident may never be known, the official death toll was 64; others argue that it may be as high as 105.[83,84,85]

State funding for biological research facilities and programs in the Former Soviet Union (FSU) has been reduced considerably since the end of the Soviet period, adding a new threat: highly capable scientists and engineers opting to leave their homelands to exchange their skills for more lucrative funding elsewhere. By 1995, approximately 300 scientists and engineers had immigrated to the US and Europe; however, there are no reliable numbers available on how many have immigrated to sensitive nations.[86] Finally, the possibility of the sale of both equipment and biological weapons materials, such as seed stock cultures, to other nations makes the FSU an on-going biological weapons proliferation threat.[87]

The US has recently begun to dismantle some of the biological facilities in the FSU and improve the security at others.[88,89] In 1994, the International Science and Technology Center (ISTC), with offices throughout the FSU, began issuing grants to bioweaponeers. These grants were seen as an opportunity to provide needed funding to cash-strapped FSU scientists, to encourage FSU scientists to move towards peaceful research, to smooth the transition to a market economy, to persuade FSU scientists to work within a broader, global scientific community, and to help solve national and international technical problems. In addition to ISTC, many agencies in the US and various European governments, many

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[83]Kenneth Alibek, *Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World–Told from Inside by the Man Who Ran It*, New York, NY: Random House, 1999.

[84] Jonathan B. Tucker, "Biological Weapons in the Former Soviet Union: An Interview with Dr. Kenneth Alibek," *The Nonproliferation Review*, Spring/Summer 1999.

[85] Jean Guillemin, *Anthrax: The Investigation of a Deadly Pathogen*, Berkley, 2001.

[86] As defined by the Department of Energy due to concerns about their activities which affect U.S. national security interests, including but not limited to nuclear proliferation, regional instability, and/or support for terrorism. The list (as of April 2003) includes: Algeria, Armenia, Azerbaijan, Belarus, People's Republic of China and Hong Kong, Cuba, Georgia, India, Iran, Iraq, Israel, Kazakhstan, Korea, North (Democratic People's Republic), Kyrgyzstan, Libya, Moldova, Pakistan, Russia, Sudan, Syria, Taiwan, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

[87] Amy E. Smithson, "Toxic Archipelago: Preventing Proliferation from the Former Soviet Chemical and Biological Weapons Complexes," The Henry L. Stimson Center, Report No. 32, 1999.

[88] Office of the Secretary of Defense, *Proliferation: Threat and Response*, US Department of Defense, January 2001. http://www.defenselink.mil.

[89] GAO, "Cooperative Threat Reduction Annual Report for FY 2004," GAO-03-1008R, 2003.

independent foundations, and the European Union fund programs and activities, such as the Cooperative Threat Reduction (CTR) program, aimed at preventing the dissemination of equipment, personnel, and information from the FSU to sensitive nations.[90,91] One such CTR effort initiated in the late 1990s, the Biological Weapons Proliferation Prevention program targeted biosecurity and biosafety enhancements, collaborative research, and facilities and equipment dismantlement.[92]

Iraq also chose to ignore the BWC prohibitions. Prior to the Gulf War in 1991, US military intelligence confirmed that Iraq—a signatory to the BWC—was developing both *Bacillus anthracis* and botulinum toxin for use in biological weapons. Iraq's program is believed to have begun in either the mid-1970s[93] or the early 1980s.[94] The Iraqi program worked with cholera, plague, *Salmonella* spp., ricin, aflatoxins, haemorrhagic conjunctivitis virus, staphylococcal enterotoxins, and camel pox.[95] Because this work continued when Iraq was engaged in a war with Iran, the US failed to understand the implications of Iraqi purchases of test animals from Western nations and strains of diseases from the American Type Culture Collection (ATCC). By the time of the Iraqi invasion of Kuwait in 1991, Saddam Hussein had ordered an acceleration of Iraq's biological weapons program, including the loading of weaponized biological agents onto missiles. Many experts suggest that the chief reason these missiles were not deployed in the 1991 Gulf War was President Bush's threat of nuclear retaliation in the event of biological attack.[96,97,98,99]

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[90]Ibid.

[91] Office of the Secretary of Defense, *Proliferation: Threat and Response*, US Department of Defense, January 2001. http://www.defenselink.mil.

[92] Amy Woolf and Michelle Stem Cook, "Preventing Proliferation of Biological Weapons: US Assistance to the Former Soviet States," CRS Report for Congress: CRS-11, April 10, 2002.

[93] Milton Leitenberg, "An Assessment of the Threat of the Use of Biological Weapons or Biological Agents," Center for International and Security Studies, University of Maryland, September 2000.

[94] C. J. Davis, "Nuclear Blindness: An Overview of the Biological Weapons Programs of the Former Soviet Union and Iraq," *Emerging Infectious Diseases, 5*,. 1999.

[95]Ibid.

[96] US State Department, "Iraq Weapons of Mass Destruction Programs," White Paper, February 13, 1998. http://www.state.gov/www/regions/nea/iraq_white_paper.html.

[97] Gregory Koblenz, "Countering Dual-Use Facilities: Lessons from Iraq and Sudan," *Jane's Intelligence Review*, March 1, 1999.

[98] Barry Kellman, "Biological Terrorism: Legal Measures for Preventing Catastrophe," *Harvard Journal of Law & Public Policy, 24*(2), Spring 2001.

[99] Tom Mangold and Jeff Goldberg, *Plague Wars: The Terrifying Reality of Biological Warfare*, New York, NY: St. Martin's Press, 1999.

The Iraqi biological weapons program provoked concern internationally and resulted in a series of UN sponsored inspections. The UN Special Commission (UNSCOM) was formed in 1991 to provide on-site inspection teams to verify the destruction, removal, or rendering harmless of all Iraqi WMD, including ballistic missiles with range greater than 150 kilometers, as well as any related production facilities and equipment. UN Security Council Resolution 687 that created UNSCOM also called for continued monitoring and verification of Iraq's compliance and required Iraq to declare the location, amounts, and types of all such items that fell under UNSCOM's authorization. Initially, Iraq provided a declaration of all their WMD, but claimed not to have a biological weapons program.[100] Throughout the 1990s, Iraq continually delayed and prevented inspectors from gaining access to inspection sites, despite a series of UN Security Council resolutions. As a result of these obstacles, the UNSCOM staff completely withdrew from Iraq by December 1998. In December 1999, the UN Monitoring Verification and Inspection Commission (UNMOVIC) replaced UNSCOM.[101,102] However, UNMOVIC met the same resistance, and the Commission was unable to make a single inspection until late November 2002. Iraq granted the inspectors access only after considerable pressure from the international community. In October 2002, the US Congress had passed a resolution authorizing the use of unilateral force against Iraq. The following month the UN Security Council passed Resolution 1441, which called for immediate and complete disarmament, demanded full compliance with inspections, and warned that Iraq faced serious consequences as a result of continued violations.[103] Only after this pressure, in late November 2002, was UNMOVIC finally able to begin the inspection process. However, the inspections failed to uncover WMD, and Iraq continued to deny their existence in an official declaration to the UN, one which both the US and UN considered unsatisfactory. The inspection teams remained in Iraq until late March 2003, when Iraq rejected the Bush administration's ultimatum that Saddam flee or face a US invasion. Following the war in Iraq, coalition forces have as yet been unable to find biological weapons and have established no conclusive evidence of a post-1991 Iraqi program.

In addition to the FSU and Iraq, several other states have either self-identified or are suspected of developing a BW program. According to the Department of Defense (DoD), the dual-use aspect of pathogens makes determining which states are developing a biological weapons program and which are not extremely difficult. For example, Iran continues to acquire dual-use biotechnology equipment under the pretext of civilian use (e.g., vaccine development), but is believed to have initiated a biological program during the Iran-Iraq war. Additionally, officials from both DoD and State have reported that Iran, among other nations, has been attempting to acquire biological weapons expertise and materials

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[100]United Nations, "UNSCOM: Chronology of Main Events," December 1999. http://www.un.org/Depts/unscom/Chronology/chronology.htm.

[101]Ibid.

[102] United Nations, "New UN Monitoring Commission for Iraq," UN Press Release SC/6775, December 17, 1999. http://www.un.org/peace/19991217.sc6775.doc.html.

[103] US Department of State, "A Decade of Deception and Defiance," September 2002. http://www.state.gov/p/nea/rls/13456.htm

from the FSU.[104] Evidence suggests that Iran has a limited offensive program and may be working to expand its biological weapons capabilities. [105]

Other states suspected of biological weapons development or interest in developing biological weapons programs as identified by the US government, include: [106,]

- China – The Chinese program is believed to have been started in the 1950s with some indications that biological weapons research is being conducted at two civilian research facilities that are under de-facto military control. Although China became a state party to the BWC in 1984, China's CBM-mandated declarations have not resolved US concerns, and the US believes strong indications exist that China maintains its offensive program.

- Syria – The Syrian program is identified primarily as a state of proliferation concern. Syria has a biotechnological infrastructure and is suspected of pursuing an offensive program.[107] Syria is a signatory to the BWC.

- Libya – The Libyian biological weapons program is believed to be at the research and development stage.[108] Libya is neither a state party nor a signatory to the BWC. In December 2003, Libya pledged to dismantle its weapons of mass destruction, including biological, programs.[109]

- India – The Indian program is believed to include civilian facilities that conduct limited biological weapons defensive work. India is a state party to the BWC.

- Pakistan – The Pakistani program has limited biological weapons research capabilities, but is seeking foreign technology and equipment to create a biotechnology infrastructure. Pakistan is a state party to the BWC.

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[104] "Biological Weapons: Efforts to Reduce Former Soviet Threat Offers Benefits, Poses New Risks," Report to Congressional Requesters: US General Accounting Office, April 2000.

[105] United States Arms Control and Disarmament Agency, *Adherence to and Compliance with Arms Control Agreements*, Washington, DC: United States Arms Control and Disarmament Agency, 1998.

[106]Office of the Secretary of Defense, *Proliferation: Threat and Response*, US Department of Defense, January 2001. http://www.defenselink.mil .

[107] United States Arms Control and Disarmament Agency, *Adherence to and Compliance with Arms Control Agreements*, Washington, DC: United States Arms Control and Disarmament Agency, 1998.

[108] Ibid.

[109] George W. Bush, "Libya Pledges to Dismantle WMD Programs," Washington, D.C., December 19, 2003. http://www.state.gov/p/nea/rls/rm/27459.htm

- North Korea – The North Korean program is suspected of being large-scale and operational since the 1960s[110,111] North Korea is a state party to the BWC.

In addition, South Africa had a fully developed biological weapons program, which was eliminated after the collapse of apartheid. In contrast to the programs discussed above, the South African program was designed primarily for assassination of anti-apartheid activists. There is limited information that indicates South Africa may also have used *Bacillus anthracis* during the Rhodesian (formally Zimbabwe) war of independence.[112] This information remains unverified. The director of the South African biological weapons program, Wouter Basson, was put on trial facing 46 charges, including sixteen counts of murder and thirteen counts of conspiracy to murder using biological weapons; however, he was acquitted of all charges in April 2002. [113,114,115] South Africa is now a state party to the BWC, but questions over South African BW still remain. According to The Washington Post, it is still unknown if the biological weapons that South Africa possessed were destroyed, and, if not, where these weapons are currently housed.[116]

Bulgaria was also believed to have had a biological weapons program intended primarily for assassination. In 1978, Bulgarian dissident Georgi Markov was killed in England after being injected with a tiny metallic sphere that contained ricin. An additional attack in 1978 against dissident Vladimir Kostov, also involved ricin; however, Mr. Kostov did not die from that attack.[117] Bulgaria is currently a state party to the BWC.

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[110] William S. Cohen, "Preparing for a Grave New World," *The Washington Post*, July 26, 1999.

[111] United States Arms Control and Disarmament Agency, *Adherence to and Compliance with Arms Control Agreements*, Washington, DC: United States Arms Control and Disarmament Agency, 1998.

[112] Tom Mangold and Jeff Goldberg, *Plague Wars: The Terrifying Reality of Biological Warfare*, New York, NY: St. Martin's Press, 1999.

[113] Tom Mangold and Jeff Goldberg, *Plague Wars: The Terrifying Reality of Biological Warfare*, New York, NY: St. Martin's Press, 1999.

[114] Desmond Blow, "Basson Hints US Helped SA Develop Chemical Weapons," *City Press News*, July 28, 2001. http://www.news24.com/City_Press/City_Press_News/0,1885,186-187_1059036,00.html

[115] SADOCC (South Africa Documentation and Cooperation Center), "South Africa: Wouter Basson Acquitted Among Strong Protests," April 12, 2002. http://www.news24.com/City_Press/City_Press_News/0,1885,186-187_1059036,00.html

[116] Joby Warrick and John Mintz, "Lethal Legacy: Bioweapons for Sale," *The Washington Post*, April 20, 2003.

[117] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*. Center for Counterproliferation Research, Washington, D.C.: National Defense University, August 1998 (Revised February 2001).

Sudan and Cuba have also been identified as pursuing biological weapons research.[118,119] Other states that may have a biological weapons program according to open literature but not confirmed by the DoD, include Israel,[120] Taiwan,[121] and Egypt.[122]

2.1.3 Revisiting the BWC

The BWC has thus far seen only limited success in curbing the proliferation and guaranteeing the destruction of biological weapons. These limitations became most obvious following the dissolution of the Soviet Union when it was discovered that, far from ending their offensive BW program, the Soviets expanded it into the largest biological weapons infrastructure in the world.

Although 146 countries have ratified the BWC, the remaining 45 states recognized by the United Nations have not. While most of these non-member countries have little or no military capabilities, at least three critical nations —Egypt, Israel, and Syria — are conspicuously absent from the list of states parties. These three refusals, all inexorably linked to one another, have contributed to an elevated level of political tension and distrust in the Middle East. Universal ratification of the BWC, while not an absolute assurance of biological weapons control, would be an encouraging development toward greater global stability.

The greatest point of contention within the BWC is the issue of verification. The BWC does not have a verification regime. Verification measures are typically the most difficult clauses to agree upon and the BWC was negotiated in a relatively short amount of time (1969-1972). Over the last decade, though, the international community has attempted to create an effective verification and inspection regime. In 1991, an Ad-Hoc Group of Government Experts was created to address the vexing problem, but all efforts failed when their draft Protocol was rejected outright by the United States in 2001.

The justification for US rejection of the verification protocol stemmed from reasons relating to the unique nature of biological agents, as compared with other WMD-related materials, and the need to ensure industrial confidence. According to John Bolton, Under Secretary of State for Arms Control and International Security, "the draft Protocol would have been singularly ineffective…for three reasons: first,

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[118] "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions: 1 January through 30 June 1998," *Nonproliferation Center*. http://www.odci.gov/cia/publications/bian/bian.html.

[119] United States Arms Control and Disarmament Agency, *Adherence to and Compliance with Arms Control Agreements*, Washington, DC: United States Arms Control and Disarmament Agency, 1998.

[120] "Israel," Center for Defense Information's Chem-Bio Weapons Site. http://www.cdi.org/issues/cbw/israel.html.

[121] "Taiwan," Center for Defense Information's Chem-Bio Weapons Site. http://www.cdi.org/issues/cbw/taiwan.html

[122] Disarmament Forum, "Biological Weapons: From the BWC to Biotech," 2000.

it was based on a traditional arms control approach that will not work on biological weapons; second, it would have compromised national security and confidential business information; and third, it would have been used by proliferators to undermine other effective international export control regimes."[123]

Following the rejection of the Protocol, the states parties agreed to hold three annual meetings starting in 2003 to discuss alternatives to strengthen the Convention other than intrusive declarations and inspections. The topics include (1) national legislative measures outlawing the use of biological weapons, (2) securing pathogenic biological materials and toxins from theft, (3) national responses to suspicious disease outbreaks, (4) international disease surveillance, and (5) codes of conduct for those who work with pathogenic agents. It is hoped that decisions made at these meetings will augment the BWC with workable and efficient measures to curb the proliferation of biological weapons.

2.1.4 Summary

The overall pattern of use throughout history strongly suggests that states view biological weapons as tactical, not strategic, weapons. A summary of state programs (confirmed and alleged), their years of operation, and the types of agents they explored are presented in Table 1.

Table 1. Summary of State Programs

State	Year	Types of Activities
Germany	1914–45 (sporadic)	R&D and Deployment
France	1914–41 (sporadic)	R&D and Possible Deployment
Japan	~1918–45	R&D Production, and Deployment
USSR/FSU	1920s–present	R&D Production, and Possible Deployment
UK	1936–69	R&D and Production
Canada	Post WWI–1969	R&D and Production
US	1942–69	R&D and Production
Iraq	1980s–(2003)?	R&D and Production
Iran	? (intensified in 1995)–-present	R&D
China	1950s–present	R&D
Syria	? – present	R&D
Libya	? – present	R&D
India	? – present	R&D
Pakistan	? – present	R&D
North Korea	1960s–present	R&D; possible production
South Africa	? –1994	R&D, Production, possible deployment

[123] John Bolton, Transcript of Speech: "The U.S. Position on the Biological Weapons Convention: Combating the BW Threat," Tokyo, Japan, August 27, 2002.

Sudan	? – present (?)	R&D
Israel	? – present	R&D
Taiwan	? – present	R&D
Egypt	? – present	R&D

Overall, state programs tend to explore similar types of pathogens and toxins for weaponization. These pathogens or toxins include the following:

Bacterial agents: anthrax, plague, tularemia, brucellosis, typhoid fever

Rickettsial agents: typhus, Rocky Mountain Spotted fever, Q fever

Viral agents: smallpox, influenza, yellow fever, encephalitis (various), Dengue fever, chikungunga, Rift Valley fever, hemorrhagic fevers (Ebola, Marburg, Lassa)

Toxins: botulinum toxin, staphylococcus enterotoxin, shigella toxin, aflatoxin

Fungal agents: coccidiodomyocosis

Other: anti-plant, anti-animal (FMD, Newcastle disease virus)[124]

2.2 Substate Actors

Substate actors are individuals or groups that act outside of a nation-state's governing institutions. It has long been assumed that substate actors would find biological weapons an attractive a tool of terrorism because of their low production costs. Additionally, pathogens, in contrast to other components of WMD, are widely available and in some cases may take less training and expertise to use in a nefarious fashion. Furthermore, biological materials emit very little energy, making detection of small amounts of material from a distance far more difficult than for other WMD components.

The threat of a substate actor using a biological weapon in terrorism against the state is a primary concern of the US. While the US had always been aware of the threat of bioterrorism, the fall 2001 anthrax attacks focused attention on the issue and prompted increased biodefense efforts. This section defines the types of substate actors and explores the historical pattern of bioterrorism incidents, pathogen possession, attempted pathogen acquisition, and incidents of pathogen diversion. It concludes with an analysis of the bioterrorism threat.

Bioterrorist acts discussed in this section are limited to the same time period as the previous section (1900–present). Unless otherwise noted, reported incidents come from the Monterey Institute of

[124] Steven M. Block, "Living Nightmares: Biological Threats Enabled by Molecular Biology," *The New Terror: Facing the Threat of Biological and Chemical Weapons*, Sidney, B. Drell, Abraham D. Sofaer, and George D. Wilson (Eds.), Stanford, CA: Hoover Institution Press, 1999.

International Studies (MIIS) terrorism database. [125] As noted in Section 1.1.3, biocrimes are not discussed.

2.2.1 Types of Substate Actors

In an effort to simplify a complex issue, terrorists and terrorist organizations are placed within one of six categories. However, it is crucial to note that many actors may be justifiably placed in more than one category. This said, it is helpful to categorize the ideological underpinnings that inform terrorist motivations, goals, and strategies for using biological weapons.[126,127,128] This section explores the main categories of terrorist groups and organizations, the historical pattern of bioterrorism incidents, possession, attempted acquisition, and cases of pathogen diversion. It concludes with a general analysis of the overall threat that terrorists pose to the US in terms of intentional pathogen and toxin use.

2.2.1.1 Social Revolutionaries

Social revolutionary groups seek to replace capitalist economic, political, and social systems with socialism. Such groups were most active in the 1970s and 1980s. Germany's Red Army Faction, Italy's Red Brigades, the Japanese Red Army, Peru's Sendero Luminoso, and Colombia's Revolutionary Armed Forces (FARC) are examples of social revolutionaries. Although a number of these groups have remained active after the fall of the Soviet Union, their numbers worldwide have diminished. Several factors create disincentives for social revolutionary groups to use biological weapons: the need to maintain support among the country's population and external supporters, unfamiliarity with biological weapons, and difficulty acquiring and using biological weapons. For social revolutionaries, the reliability and versatility of conventional weapons has tended to overshadow the allure of biological weapons.

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[125] The Monterey database does not restrict itself to documenting only incidents involving the actual use of a military-grade biological agent—it includes information referring to any indication of interest by subnational groups or individuals in biological materials. According to clearly delineated criteria, in certain circumstances incidents involving the use of non-warfare agents, the infliction of minimal casualties, and even threats of biological agent use are included in the database. See: Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[126] Richard Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer. *America's Achilles Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, Cambridge, MA: MIT Press, 1998.

[127] Jerrold M. Post, "Aum Shirinkyo (1995).," *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker (Ed.), Cambridge, MA: MIT Press, 2001.

[128] Jonathan B. Tucker, Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons, Cambridge, MA: MIT Press, 2001.

2.2.1.2 Nationalist-Separatists

Nationalist-separatist groups generally fight to establish local autonomy or state sovereignty based on a desire for ethnic dominance or homogeneity. Nationalist-separatist groups who have been active in the past decade include the Irish Republican Army (IRA), the Basque Fatherland, the Kurdistan Workers Party (PKK), Liberty (ETA), as well as radical Palestinian groups, such as the Al-Aqsa Martyrs Brigade and the Palestinian Front for the Liberation of Palestine-General Command (PFLP-GC). These groups have the same disincentives for biological weapons use that confront social revolutionary groups and historically have tended to limit their attacks to conventional weapons. However, the potential dissemination of biological weapons by nationalist-separatists remains a concern, particularly if the effects of an attack could be limited to the intended target.

2.2.1.3 Religious Groups

Over the last two decades violence by groups seeking to maintain or create a specific religious social and political order has become increasingly prevalent and lethal worldwide.[129] Religious groups that employ terrorism generally fall into one of two categories: (1) radical fundamentalists on the fringes of mainstream creeds—including Islam, Christianity, Judaism, Sikhism, and Hinduism; and (2) apocalyptic cults such as Japan's Aum Shinrikyo. Extreme, absolutist doctrines and charismatic, dominant leadership from both groups tend to overcome the normal disincentives for biological weapons use.

It is important to note that the various categories of terrorist organizations presented here are not mutually exclusive. For example, Hamas and Hezbollah could be considered both nationalist-separatist and religious groups. Their religious ideologies become intertwined with their nationalist ambitions and, as a result, their actions are not easy to predict.

2.2.1.4 Single Issue Groups

Single issue groups use terrorist activities to advance their organization's position on a particular political, economic, or social issue. While many issues could, theoretically, foster a violent response, to date the single issue groups associated with biological weapons threats have been environmental and anti-abortion groups. These biological weapons-related incidents have been low consequence events consisting of primarily hoaxes, pranks, and threats. [130] The combination of a single issue group with religious extremism could result in motivations to deploy a biological weapon.

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[129] In 1968, none of the 11 international terrorist groups identified by the State Department were religious organizations. By 1992, 11 of 50 groups were designated by the State Department as terrorist groups were religious and by 2001 that number had grown to 27 of 61. See: (1) Richard Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer. *America's Achilles Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, Cambridge, MA: MIT Press, 1998.; (2) United States Department of State. 2000. *Patterns of Global Terrorism 1999*. Washington, DC: Department of State.

[130] The definition of Hoax/Prank/Threat as listed within the Monterey Institute database: a hoax occurs if the perpetrator claims that s/he used an agent in the commission of an act and delivered a "fake" substance in place of the real thing. Pranks only differ from hoaxes in that there is no "fake" substance delivered with the claim. The

2.2.1.5 Right-Wing Groups

Terrorist groups on the Right include a diverse set of groups, including xenophobic groups, neo-Nazis, skinheads, white supremacists, tax protesters, patriot militias, and fundamentalist Christian groups. Over the last 20 years, Right-wing violence has increased as social-revolutionary activity has declined. Right-wing violence has also become increasingly secular. Rightist violence has tended to be unsystematic and on a small scale—with the notable exception of the 1995 Oklahoma City bombing of the Murrah Federal Building. That incident, and association of conservative politics with religious fundamentalism in a number of countries, suggests that Right-wing terrorists pose a threat of high consequence events.[131] Such events could include an escalation to biological weapons attacks, as these groups have participated in an increasing number of biological weapons hoaxes, threats, and pranks in the last decade. Additionally, several individuals who associate themselves with these groups have been found in possession of potential biological weapons agents.

2.2.1.6 Lone Actors

Perhaps the most difficult substate actor to assess is the individual who operates outside of a group. Lone actors are the broadest, least predictable category of terrorists, spanning all the ideological incentives that motivate groups, as well as a variety of individual pathologies such as personal frustrations, revenge, economic gain, and perverse pleasure. Studies on insider espionage[132] and computer hacking[133] indicate that individual motivations for anti-social behavior are extremely difficult to isolate.[134] Most bioterrorism incidents involving lone actors are hoaxes or threats, likely because relatively few individuals have the capability or skill to acquire and use biological weapons. Indeed, the vast majority of perpetrators identified in the rash of biological hoaxes and threats after 1998 were lone actors. While some lone actors clearly had the capability to acquire and use low consequence biological agents and basic delivery methods, most did not. Nonetheless, a knowledgeable lone actor remains a danger. The lone actor

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threat element is when there is no evidence of possession by the perpetrator. As there is no confirmation of a realistic threat of actual use, these cases are placed on the same level as hoaxes or pranks. See: Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[131] Chemical and Biological Arms Control Institute and Lawrence Livermore National Laboratories, "The 'New Terrorism': Does It Exist? How Real Are the Risks of Mass Casualty Attacks?" Report of Proceedings, April 29-30, 1999. http://www.cbaci.org/Newterrorism.htm

[132] Defense Security Service, "Treason 101," 2001. http://www.dss.mil/training/csg/security/Treason/Intro.htm#Treason_101

[133] Sarah Gordon, "Studying the Psychology of Virus Writers and Hackers," 2001. http://www.pbs.org/wgbh/pages/frontline/shows/hackers/whoare/psycho.html

[134] Jerrold M. Post, "Aum Shinrikyo (1995)," *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker (Ed.), Cambridge, MA: MIT Press, 2001.

arguably poses the greatest threat as an insider, a scientist or technician with legitimate access to dangerous pathogens and toxins, and possibly the expertise to weaponize it.

2.2.2 Bioterrorism Incidents

The earliest reported incident of bioterrorism within the time period studied occurred in 1910. The Pancho Villa guerillas, a nationalist-separatist group engaged in combat with federal troops during the Mexican revolution, used botulinum toxin that was cultured by placing cooked green beans in a sealed canister. Rotting pork was added to the beans one week later. The mixture was then buried in the canteens until swelling indicated the toxin was ready for use. Children dipped pottery shards or obsidian into the mixture and threw the shards at federal sentries. There is no report on the overall effectiveness of this incident.[135]

The next reported incident of bioterrorism occurred in 1947 but it lacks sufficient evidence for formal confirmation, according to MIIS. Allegedly, Palestinian Jewish groups used cholera against various water supplies in both Egypt and Syria in order to attack civilian populations. No injuries or casualties were reported. This alleged incident exemplifies the often intertwined goals of nationalist-separatist and religious groups.[136]

The first incident of agroterrorism within the studied time period occurred in Kenya in 1952. A nationalist-separatist group called the Mau Mau used African milk brush as a toxin against livestock. The Mau Mau cut incisions into the skin of 33 steers and put the latex of the plant directly into the wounds. Although eight steers died, the attack did not allow the Mau Mau to achieve their goal of independence.[137,138]

In 1981, Dark Harvest, a single-issue group focused on environmental extremism, attempted to attack the scientists of Porton Down. Members of Dark Harvest delivered a package containing soil contaminated with *Bacillus anthracis* from Gruinard Island in an effort to protest the island's environmental degradation.[139,140] The group intended to return of the "seeds of death" to their sources.[141] No injuries resulted from this attack.

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[135] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[136] Ibid.

[137] Ibid.

[138] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*, Center for Counterproliferation Research. Washington, D.C.: National Defense University, August 1998 (Revised February 2001).

[139] See section 2.1.1.3 on the British biological weapons program for a more detailed description of the *Bacillus anthracis* experiments conducted on Gruinard Island.

One of the most significant incidents of bioterrorism occurred in the summer of 1984. On six separate occasions, the Rajneeshee religious cult deliberately contaminated salad bars with salmonella bacteria[142] in The Dalles, Oregon. The cult was founded in India in the 1960s by Bhagwan Shree Rajneesh. By 1981, when the cult relocated to the US, its membership had grown to include wealthy followers, lawyers, and lab technicians. Prior to the 1984 attack, the cult had engaged in numerous legal battles with other Wasco County residents, and had unsuccessfully tried to "take over" the county through the electoral process. When this failed, they attempted to keep other members of the county away from the ballots on Election Day by sickening enough residents to influence the outcome of the elections. The group purchased salmonella in the form of "bactrol disks" from Seattle based medical supplier VWR Scientific. The Rajneeshee attacks resulted in 776 cases of illness, but no deaths. [143]

The malicious nature of the event went unnoticed until a Rajneeshee cult member confessed after being arrested on unrelated charges over a year after the event.[144] Although the Rajneeshee failed to achieve their ultimate goal—winning the election and gaining control of the town—the 1984 attacks succeeded in showing the real danger of bioterrorism. Even more troubling is that the group also possessed *Salmonella typhi* (the causative agent for typhoid fever). While we cannot know whether the group—if they indeed possessed the bacteria—intended mass casualties, the mere fact that they may have possessed *Salmonella typhi* is cause for concern. [145,146,147,148]

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[140] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*, Center for Counterproliferation Research, Washington, D.C.: National Defense University, August 1998 (Revised February 2001).

[141] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[142] Salmonella is a food-borne disease most often associated with spoiled fish, chicken, eggs, and dairy products and can cause severe gastrointestinal distress, fever, cramps, and diarrhea soon after infection. Although victims can become dehydrated by diarrhea and may require hospitalization, they usually recover within 4 to 7 days without treatment. In rare cases, the disease can spread from the intestines to the blood stream and cause infection in other parts of the body, leading to death if not treated with antibiotics. See Centers for Disease Control and Prevention, Division of Bacterial and Mycotic Diseases, "Salmonellosis," 2000. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_g.htm.

[143] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[144] Jessica Stern, *The Ultimate Terrorists*, Cambridge, MA: Harvard University Press, 1999.

[145] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[146] W. S. Carus, "The Rajneeshees (1984)," *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*. Jonathan B. Tucker (Ed.), Cambridge, MA, MIT Press, 115-138, 2000.

[147] Jonathan Tucker and Amy Sands, "An Unlikely Threat," *The Bulletin of Atomic Scientists*, *55*(4), July/August 1999.

In 1989, a single-issue group in California, the Breeders, undertook a campaign of threatened agroterrorism. The group was primarily concerned with the use of pesticides in agriculture. The Breeders openly challenged the agricultural industry by threatening to release the Medfly every time they witnessed any type of crop dusting. While researchers were unable to determine whether or not the Breeders followed through on their threat, they did notice unusual patterns to the Medfly infestation. Nevertheless, the Breeders neither caused any significant damage nor affected any change in agricultural pesticide use. Despite an investigation by USDA and other organizations, the Breeders seemed to have dispersed following their original threat.[149]

In the early 1990s, the Japanese religious cult Aum Shinrikyo made several attempts at bioterrorism, but is best known for successfully disseminating sarin gas in the Tokyo subway in 1995. The Aum Shinrikyo cult was led by the charismatic leader Shoko Asahara, who had an apocalyptic vision for a new world where he would be supreme leader. Asahara founded the company Aum Inc. in 1984; he also ran yoga clinics and produced health drinks. He soon became interested in spirituality and began to claim that he had supernatural powers. As his fame grew, so did his funding. Eventually, Asahara told followers that God had spoken to him and had chosen him to lead God's army. He began to follow the teachings of a historian who claimed Armageddon would come in the year 2000, leaving few survivors. The survivors' leader would be from Japan. Shortly thereafter, Asahara changed the name of his company to Aum Shinrikyo, or Supreme Truth.

In order to prepare for a nuclear war that he had originally thought would commence in the late 1980s, Asahara recruited scientists to develop his own chemical and biological weapons arsenal.[150] By the early 1990s, the cult had developed an extensive biological weapons capability to carry out its doomsday agenda. Aum Shinrikyo's program had a cadre of university and graduate-level trained microbiologists, dedicated to creating biotechnology facilities with significant funding. They worked undetected for four years. Their first targets, in April 1990, were the US Navy bases at Yokohama and Yokosuka, the Narita airport, the Japanese Diet, and the Imperial Palace. The group attempted to disseminate botulinum toxin in the form of mist sprayed from a truck. This attempt failed for unknown reasons. Investigators suspect that the group may have used a weak strain of the toxin. [151,152]

There were six subsequent attacks in 1993, all of which failed. The first of these attacks—June 1993—used botulinum toxin directed at guests of the wedding of Prince Naruhito. Similar to the previous attack,

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[148] Leonard Cole, "The Specter of Biological Weapons," *Scientific American*, December 1996. http://www.sciam.com/1296issue/1296cole.html

[149] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[150] Jessica Stern, *The Ultimate Terrorists*, Cambridge, MA, Harvard University Press, 1999.

[151] Kyle B. Olson, "Aum Shinrikyo: Once and Future Threat?" *Emerging Infectious Diseases*. *5*(4), July/August 2000.

[152] W. J. Broad, S. Wu Dunn, and Judith Miller, "How Japan Germ Terror Alerted World," *The New York Times*, May 26, 1998.

the group sprayed a mist of the toxin from a car. By the time of the second attack—July 1993—the group had switched to *Bacillus anthracis*. Aum Shinrikyo attempted to spray *Bacillus anthracis* spores from the top of their Kameido compound in Tokyo. The spray device was equipped with a fan that would further disseminate the agent. Residents of the neighborhood noticed a foul odor. When police investigated further, residents also reported a sticky substance on the street as well as "steam" coming from the Aum Shinrikyo compound. Aum Shinrikyo refused to allow the police into its building for further inspection. Three more anthrax incidents occurred in July 1993. All these disseminations were aimed at civilians in Tokyo, including two attempts at dissemination of the bacteria from a moving vehicle and one from the roof of its compound. The key factor in Aum Shinrikyo's failure was use of a vaccine strain of anthrax.[153] The last incident occurred in March 1995, when the group again attempted to disseminate botulinum toxin from three brief cases equipped with spraying devices. This attempt failed because the cult member responsible for placing the brief cases changed his mind and replaced the toxin with water.[154]

In spite of extensive expertise and resources, Aum Shinrikyo's efforts to produce an effective biological weapon were unsuccessful. The Aum Shinrikyo cult gathered their biological collection from a variety of sources. In 1990, Asahara sent a team to Hokkaido Island, Lake Akan, Kunashiri Island, and Tokachi River to collect *Clostidium botulinum* from soil samples. They also purchased *Clostridium botulinum* from a pharmaceutical company through a "front" company. They purchased various types of equipment in order to process their biological weapons. When police raided their biological weapons facility in Kamikuishiki, Yamanashi Prefecture, they found 17 buildings containing 300 books on biochemistry, books on culturing botulinium toxin, a computer disk containing information on biological weapons research, bacteria incubators, actual cultures, and various chemicals. Police also found blueprints for the construction of a bioscience research facility, indicating Aum Shinrikyo was planning to build a four-story, steel-framed structure approximately 1,700 square meters and surrounded by concrete.[155, 156,157] Despite their efforts, no injuries or fatalities resulted from any of Aum Shinrikyo's bioterrorism activities.

Another attempted bioterror incident occurred in Tajikistan in 1995 and involved an Afghani warlord's acquisition of hepatitis virus from a local hospital. He subsequently sold infected fruit to Russian troops in Tajikistan as part of an effort to aid nationalist-separatists movements in Tajikistan. Notably, there was a small number of subsequent hepatitis illnesses among Russian troops during this same time period.[158]

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[153] Milton Leitenberg, "The Experience of the Japanese Aum Shinrikyo Group and Biological Agents," *Hype or Reality? The New Terrorism and Mass Casualty Attacks*, Brad Roberts (Ed.), Alexandria, VA, The Chemical and Biological Arms Control Institute, 159–170, 2000.

[154] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[155] Ibid.

[156] Kellman, "Biological Terrorism: Legal Measures for Preventing Catastrophe," op. cit.

[157] Jessica Stern, *The Ultimate Terrorists*. Cambridge, MA: Harvard University Press, 1999.

[158] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

The next three incidents of bioterrorism took place in 2000. The first took place in January and involved gay sex and advice columnist Dan Savage, who reportedly attempted to infect presidential candidate Gary Bauer with influenza by first joining his presidential campaign staff and then touching, coughing, and licking various elements in Bauer's campaign headquarters (e.g., doorknobs, keyboards). Savage also asked Mr. Bauer for an autograph after sucking on the pen he had handed him. Bauer's campaign manager did come down with the flu; however, Bauer did not. Savage was charged with fraudulent voter registration and illegal voting in a primary election, but was not charged with assault.[159] Savage was particularly upset with the anti-homosexual aspects of the Bauer campaign; consequently, this attack is likely an example of a lone actor concerned with a single-issue.

The second incident occurred in May 2000, when Palestinian nationalist-separatists used a machine to place counterfeit stamps on expired and salmonella-tainted eggs destined for sale in Israel. The scheme was not detected for 18 months. Inspectors from the Israeli Agricultural Development Authority eventually discovered the scheme, and the perpetrators were apprehended. It is unknown how many individuals became sick with salmonella. A Tel Aviv woman died from salmonella poisoning during this time period.[160]

The last incident, also in Israel, occurred in June 2000. This time, Israeli settlers from the Efrat settlement on the West Bank are reported to have deliberately released sewer water into Palestinian agricultural fields. Palestinians claim that Israelis attack them annually in this manner, attempting to remove Palestinian farmers from their land. Farmers estimate their damages at approximately $5,000; however, no human infections were reported.[161] As with the prior incident in Israel, this was primarily a nationalist-separatist attack.

The most recent biological attack occurred in the fall of 2001, shortly after the 9/11 terrorist events. These attacks used letters containing weaponized anthrax[162] that were sent through the US Postal Service (USPS). Following these attacks, 11 inhalation and 11 cutaneous (7 confirmed and 4 suspected) cases of anthrax were identified in the US. Five deaths resulted from contracting the inhalation form of the disease.[163] Prior to these attacks, no US citizen was known to have died from bioterrorism within the

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[159] Ibid.

[160] Ibid.

[161] Ibid.

[162] In contrast to non-weaponized *Bacillus anthracis*, weaponized *Bacillus anthracis* has been milled to a very small particulate size so that it may more easily lodge in the smallest brachials of the lung. Additionally, the *Bacillus anthracis* had been coated with a substance to eliminate the electrostatic charge. Thus, the spores would not be attracted to one another and clump together.

[163] Thomas V. Inglesby, Tara O'Toole, Donald A. Henderson, John G. Bartlett, Michael S. Ascher, Edward Eitzen, Arthur M. Friedlander, Julie Gerberding, Jerome Hauer, James Hughes, Joseph McDade, Michael T. Osterholm, Gerald Parker, Trish M. Perl, Philip K. Russell, and Kevin Tonat, "Consensus Statement, Anthrax as a Biological Weapon, Updated "Recommendations for Management," *Journal of the American Medical Association, 287*(17), 2236–2252. May 1, 2002. http://jama.ama-assn.org/issues/v287n17/jst20007.html For a description of the US anthrax cases see: http://www.cdc.gov/nciDoD/EID/vol7no6/jernigan.htm.

US.[164] Approximately 10,000 individuals were potentially exposed to the bacteria and treatment consisting of at least 60 days of post-exposure antibiotic prophylaxis was recommended.[165] In addition, many government and public buildings were shut down because of evidence of contamination. As of this writing, the perpetrator(s) remain unknown. Consequently, specific motivations and/or group identity (if applicable) also remain unknown. Finally, although the strain of anthrax used has been identified (the Ames strain), it is unknown whether or not its release was the result of theft by an individual who had legitimate access or self-manufactured by a knowledgeable "insider."

In summary, six bioterrorism incidents have been perpetrated by national-separatist groups, with three of those also qualifying as religious groups. Two incidents have been perpetrated by right-wing groups, two incidents by single-issue groups, and two incidents by religious groups. The three most significant bioterrorism incidents have been the Rajneeshee salmonella poisoning, the Aum Shinrikyo attempted anthrax and botulinum toxin dissemination, and the unsolved anthrax attacks of 2001. Table 2 presents a summary of bioterrorist events by substate actors. This table includes both alleged and confirmed attacks.

Table 2. Summary of Bioterrorism Incidents

Actor	Type of Actor	Year	Agent(s)	Relative Success
Pancho Villa guerillas	Nationalist-separatist	1910	Botulinum toxin	Unknown
Palestinian Jewish groups	Nationalist-separatist	1947	Cholera	Unknown
Mau-Mau	Nationalist-separatist	1952	African milk brush	Successful - Eight steers killed
Dark Harvest	Single-issue	1981	*Bacillus anthracis*	Unsuccessful
Rajneeshee	Religious	1984	Salmonella typhimurium	Successful – 776 people sickened
The Breeders	Single-issue	1989	Medfly	Unknown
Aum Shinrikyo	Religious	1990—1995	Botulinum toxin, *Bacillus anthracis*	Unsuccessful
Afghani Warlord	Nationalist-separatist	1995	Hepatitis	Unknown
Dan Savage	Lone actor/single-issue	2000	Influenza	Unknown – one individual sickened but may not be related
Palestinians	Nationalist-separatist	2000	*Salmonella typhimurium*	Unknown – operation in effect for 18 months prior to detection

[164] Jonathan B. Tucker and Amy Sands, "An Unlikely Threat," *The Bulletin of the Atomic Scientists*. *55*(4):4, July/August 1999.

[165] Centers for Disease Control and Prevention, "Notice to Readers: Evaluation of Post-Exposure Antibiotic Prophylaxis to Prevent Anthrax," *MMWR*, 51(03):59, January 25, 2002. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5103a4.htm

Israeli settlers	Nationalist-separatist	2000	Sewer water (unspecified bacteria)	No human infections, possible crop damage
Unknown	Unknown	2001	*Bacillus anthracis*	Five dead, 17 injured, tens of thousands put on antibiotic treatment

2.2.3 Incidents of Possession

In addition to actual bioterrorism incidents, MIIS identifies several cases where individual(s) had unauthorized possession of pathogens but did not deploy them. Whether or not these individuals would have deployed these pathogens remains unclear. However, possession remains an important component of understanding the threat of BW use.

In 1972, two members of the radical group RISE were arrested for possession of *Salmonella typhi* with intent to release it into the water supply of Chicago. RISE can best be described as a combination of both a single-issue group and an apocalyptic (though non-religious) group. RISE was concerned with the impact of humans on the planet and believed that all but a small group of people should be killed. Originally, RISE considered using several agents (including anthrax, cholera, and meningitis) in an effort to confuse public health officials. However, the two potential perpetrators were discovered before they could implement the plan. After their arrest, both members were arraigned on bail. They immediately flew to Jamaica. In 1972, they hijacked an aircraft and flew to Cuba. One was subsequently arrested in Cuba for counter-revolutionary activities and died in 1974; the other returned to the US in 1995, when he pled guilty and received five years' probation.[166]

In 1995, four members of the Minnesota Patriots Council—a Right-wing militia group—were tried and convicted under the 1989 Biological Weapons Anti-Terrorism Act for possession of ricin. Patriot groups throughout the US are organized under the belief that the federal government has overstepped its bounds and that all power and authority should rest solely in the hands of local officials. The men ordered a mail order ricin kit in 1991 that was advertised in a Right-wing bulletin. They intended to mix the ricin with hand lotion that they planned to distribute to government officials, sheriffs, US Marshals, and IRS agents. A dispute erupted between one of the conspirators and his wife, resulting in the wife's decision to turn the ricin over to local authorities. When convicted, each man received prison sentences of less than five years.[167]

Also in 1995, Thomas Lewis Lavy was found in possession of 130 grams of ricin with intent to use the toxin as a weapon. Additionally, officials found approximately 1.5 pounds of castor beans at his home along with books detailing how ricin is made. Previously, Lavy had been stopped at the US-Canadian border with ricin; however, he was not arrested. Lavy claimed that the ricin was for killing coyotes

[166] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[167] Ibid.

around his Arkansas home, but he is believed to have maintained ties with local survivalist groups and far-Right Christian fundamentalist groups. Lavy hanged himself in jail in 1995.[168]

Perhaps the most famous incident of pathogen possession is that of Larry Wayne Harris. In 1995, Harris ordered three vials of plague from the ATCC using his employer's state certification. The ATCC became suspicious of Harris and notified the Centers for Disease Control and Prevention (CDC). A 1997 raid on Harris' home discovered the three vials, which were still in their original container.[169] A further search of his home found explosives and material indicating that Harris was a member of the Right-wing group Aryan Nation, a white supremacist organization. Because it was not illegal to possess human pathogens, Harris was arrested for obtaining the bacteria through falsified documents. Harris claimed that he was researching the pathogen to counter what he believed was a threat from Saddam Hussein to release "super-germ-carrying rats" in the US. Harris was subsequently convicted in 1997.[170]

James Dalton Bell was discovered with ricin and botulinum toxin in 1997. Bell had a long history of anti-US government activity. In 1989, police found 10 barrels of phenyl acetic acid (used for the production of methamphetamine) in Bell's possession. Bell was charged for failing to report the receipt of chemical substances. In 1997, IRS officials searched Bell's home and found numerous chemicals, including hydrochloric acid, sodium cyanide, nitric acid, and sulfuric acid as well as the two toxins. Also in 1997, federal officials raided the home of Bell's friend Robert East looking for information on Bell. The warrant specified that the agents were looking specifically for anthrax, sarin, and rocket launchers. Again in 1997 after being arrested that day for tax violations, Bell exploded a "stink bomb" at the IRS office in Vancouver, Washington using the chemical mercaptan. Bell served 11 months for incidents related to tax violations and was released in April 1998 with three years probation. Bell violated the conditions of his parole by threatening US officials. He was convicted in 1999 on four felony counts of threatening individuals via e-mail. By 2000, Bell was out of prison and had been rearrested for stalking two Treasury Department agents.[171] Bell's anti-government rhetoric places him within the Right-wing group designation.

In 1997, a British newspaper published an article based on an interview with Seydo Hazar, an ex-member of the Kurdistan's Worker's Party (PKK)—a nationalist-separatist group that advocates the creation of a Kurdish state. In the article, Hazar claimed that the PKK had been exploring several different types of crude delivery systems for rat poison, sarin, and potassium cyanide. In addition to these, Hazar reported

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[168] Ibid.

[169] The two-year delay in investigating Harris was likely because the first "select agent" law was not signed until 1996.

[170] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[171] Ibid.

that PKK possessed *Escherichia coli O157:H7* and botulinum toxin. The weapons were to be used to kill tourists on Turkish beaches.[172]

In 1997, Thomas C. Leahy threatened to poison his mother and former wife with homemade ricin. He also had indicated that he was making a "killer virus" that he planned to place on razor blades and then send to "his enemies" through the mail. In addition, Leahy claimed to have developed an airborne bacterium that he planned to distribute in a similar fashion. Leahy pled guilty to engaging in terrorist acts and received a 12-year term; however, on appeal that sentence was reduced to six and a half years.[173] Although Leahy specifically threatened family members (making this incident a biocrime rather than a bioterrorist event), the group that comprised his "enemies" was never fully determined. Thus, Leahy can best be described as a lone actor with unspecified goals.

Also in 1997, the journalist Steve Emerson reported that Israeli intelligence believed Hamas, an Islamic fundamentalist group, had possession of unspecified biological weapons components. These components were allegedly obtained from various Israeli hospitals. In addition, a 1998 media report suggested that ex-CIA Director James Woolsey stated that Hezbollah, another Islamic militant group, had acquired both biological and chemical weapons with the help of two Swiss businessmen. No further information is available on this incident and no biological agents were ever found in the possession of these organizations.[174] Both Hamas and Hezbollah are nationalist-separatist and religious groups.

In 1998, the Turkish police confiscated 960 glass tubes of cobra poison from three PKK members. As many as 1,500 tubes may have been purchased by the PKK. However, the members who were arrested in connection with this case claimed that they sold some of the tubes to an unnamed person. The venom is thought to have originated in Azerbaijan.[175]

In 2000, Chechen rebels fighting for independence from Russia reportedly acquired a "biological agent" (presumed to have been anthrax). The report originated from a source within the Dagestani Interior Ministry. The Russian spokesperson for matters relating to Chechnya refuted the report, indicating that the Russian government did not believe that the Chechens had either the technical means or expertise to effectively develop an anthrax weapon.[176]

Of the incidents of possession, four were perpetrated by Right-wing groups; three by nationalist-separatist groups; one incident each by a lone actor and single-issue group; and one incident by a group who can best be described as both a nationalist-separatist group and a religious group (Hamas/Hezbollah). Each

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[172] Ibid.

[173] Ibid.

[174] Ibid.

[175] Ibid.

[176] Ibid.

incident involved agents that could be cultured or readily obtained from nature.[177] A summary of the incidents of possession (alleged and confirmed) is presented in Table 3.

Table 3: Summary of Incidents of Possession

Actor	Type of Actor	Year	Agent(s)
RISE	Single-issue	1972	Typhoid
Minnesota Patriots Council	Right-wing	1995	Ricin
Thomas Lewis Lavy	Right-wing	1995	Ricin
Larry Wayne Harris	Right-wing	1995	*Yersinia pestis*
James Dalton Bell	Right-wing	1997	Ricin, botulinum toxin
PKK	Nationalist-separatist	1997	Escherichia coli O157:H7, botulinum toxin
Thomas C. Leahy	Lone Actor	1997	Ricin, "killer virus" (unspecified)
Hamas/Hezbollah	Religious/Nationalist-separatist	1997/1998	Unspecified BW components
PKK	Nationalist-separatist	1998	Cobra poison
Chechen rebels	Nationalist-separatist	2000	Unspecified "biological agent"

2.2.4 Incidents of Attempted Acquisition

This section examines the historical record of attempted acquisition as reported by MIIS. In all, there have been five reported attempts of acquisition; however, this summary should not be considered the definitive authority. Many agents (as is shown in the above record) can be acquired directly from nature. Consequently, these incidents only represent what MIIS has found in the public record.

In 1914, a group of anarchists attempted to smuggle cholera from Switzerland to Russia via fountain pens. These individuals were believed to be part of a larger nationalist-separatist organization.[178]

In 1980 in Paris France the social revolutionary group Baader-Meinhof (dedicated to overthrowing the German government) attempted to acquire a sample of botulinum toxin. [179] A police raid on an apartment

[177] Several of the incidents report only unspecified "biological agents." Without additional information, it is impossible to characterize the agents.

[178] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

in Paris uncovered a miniature laboratory designed to produce botulinum toxin.[180] Also found were medical journals and papers on bacteriology. Among the various biological weapons components, police also found presses, rubber stamps, passports, forged documents, a detonator, and instructions for manufacturing bombs. However, the police failed to inventory the items found in the apartment; consequently, there is no firm record on whether or not the biological weapons components found are as listed.[181]

In 1992, Aum Shinrikyo made an attempt to acquire Ebola. Members traveled to Zaire during an outbreak to collect a sample of the virus. The group traveled under the guise of bringing medical assistance to the victims of the outbreak. They called their trip the "African Salvation Tour." Ultimately, however, the attempt was unsuccessful.[182]

In 1997, an unknown biological agent is reported to have been the object of an attempted acquisition in Sudan. The perpetrator(s) remain unknown as does their motivation and intended target. It is believed that some type of terrorist group was attempting to build a facility for both chemical and biological weapons work in Sudan.[183]

After their August 1999 arrest, individuals loyal to Osama bin Laden reported that they had been able to acquire *Bacillus anthracis* through the mail, and had attempted to obtain botulinum toxin. Such claims have an unpleasant credibility, as information exists that former Warsaw Pact countries as well as some Far Eastern nations openly supply biological agents (such as Ebola) without properly verifying the identities of the purchasers.[184] The DoD has also confirmed that followers of Osama bin Laden have trained to use toxic chemicals.[185]

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[179] The truthfulness of this event has recently been questioned. But because it is still commonly cited, it has been included in this discussion.

[180] J. D. Douglass, Jr. and N. C. Livingstone, *America the Vulnerable: The Threat of Chemical/Biological Warfare*, Lexington, MA, Lexington Brooks, 1987.

[181] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[182] David E. Kaplan, "Aum Shinrikyo (1995)." *Toxic Terror: Assessing the Terrorist Use of Chemical and Biological Weapons*. Jonathan B. Tucker (Ed.), Cambridge, MA: MIT Press, 2000.

[183] Monterey Institute of International Studies, Center for Nonproliferation Studies' Weapons of Mass Destruction (WMD) terrorism database. http://cns.miis.edu/db/wmdt/index.htm - subscription required.

[184] The Chemical and Biological Arms Control Institute, "Chemical & Biological Arms Control Dispatch," August 1-15, 1999.

[185] Office of the Secretary of Defense, *Proliferation: Threat and Response*, US Department of Defense, January 2001. http://www.defenselink.mil

Overall, there have been attempted acquisitions by two nationalist-separatist groups, one religious group, and one combination nationalist-separatist and religious group (bin Laden's Al Qaeda). The last attempted acquisition remains unclear as to whom—what type of group—was responsible. A summary of attempted acquisitions appears in Table 4.

Table 4: Summary of Attempted Acquisitions

Actor	Type of Actor	Year	Agent(s)
Anarchists	Social revolutionaries	1914	Cholera
Baader-Meinhof	Social revolutionaries	1980	Botulinum toxin
Aum Shinrikyo	Religious	1992	Ebola
Unknown	Unknown	1997	Unknown
Osama bin Laden (Al Qaeda)	Nationalist-separatists/Religious	1999–present	*Bacillus anthracis*, botulinum toxin, possibly others

2.2.5 The Special Case of Diversion

Diversion of high consequence pathogens and toxins from legitimate institutions poses a distinct threat, as such materials can be used for biological weapons proliferation or attacks. In February 2001, the US National Defense University published a study, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*.[186] In 11 of the 33 cases involving acquisition of biological agents, substate actors obtained the material from legitimate culture collections. The agents included those that cause plague, botulism, tetanus, and typhoid. The pathogens were obtained legitimately or through the use of falsified documents.[187] At the time of these events, there were no national regulations in place to control the possession or transfer of such high consequence agents. In an additional three cases, the perpetrators acquired their biological agents by stealing them from research or medical laboratories. The agents involved cause dysentery (*Shigella dysenteriae* type 2), typhoid, and roundworm. The perpetrators were "insiders," scientific staff with legitimate access to the facilities where the pathogens were kept, who

[186] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900*, Washington, DC: National Defense University, August 1998 (February 2001 Revision).

[187] In order to address individuals' ability to acquire and possess biological weapons, the US Congress passed the Biological Weapons Act of 1989, the Antiterrorism and Effective Death Penalty Act of 1996, and the Public Health and Security and Bioterrorism Preparedness and Response Act of 2002. Prior to these laws, there were no federal prohibitions on individuals possessing any biological agents regardless of their lethality or whether the individual had a legitimate use for the agents. The 1996 Antiterrorism and Effective Death Penalty Act and the 2002 Bioterrorism Preparedness and Response Act outline specific restrictions and regulations regarding the use and transfer of certain high consequence pathogens and toxins. http://usinfo.state.gov/usa/infousa/laws/majorlaw/s735_enr.htm; http://www.cdc.gov/od/ohs/lrsat/42cfr72.htm and http://www.fda.gov/oc/bioterrorism/PL107-188.pdf. For a more complete discussion on US laws, see James R. Ferguson (JD), "Policy Perspectives: Biological Weapons and US Law," *Journal of the American Medical Association*, *278*(5), 1997. This article outlines the history of attempts made by the US to regulate BW research, development, and use by individual citizens. The article does not include laws following the fall 2001 *Bacillus anthracis* attacks.

seemed to be motivated by personal grudges or desire for revenge. In all of these cases, the perpetrators identified culture collections or repositories as the preferred source for acquiring pathogens, even though they had the technical skills to culture the organisms from nature.

There is little information in the open literature related to incidents of diversion at federal laboratories. In 1986, a former researcher at the US Army Medical Research Institute of Infectious Diseases (USAMRIID) charged that 60 to 70 various sized vials containing almost 2,500 milliliters of Chikungunya virus[188] went missing in 1981. US Army officials denied that the virus had been diverted, but a Congressional hearing was held on the subject in 1988. To date there has been no resolution on what exactly happened to the missing vials.[189,190]

In 1992, an internal US Army audit found that 27 specimens of various agents were missing from USAMRIID. A search of the laboratory subsequently turned up all but three of the missing 27 specimens. It is unclear whether those specimens contained any viable or virulent microbes.[191,192] Additionally, media reports have speculated that the anthrax attacks in the United States during the fall of 2001 were perpetuated by someone who had access to and removed virulent *Bacillus anthracis* strains from a US biological research laboratory.

Although mass casualties have not resulted to date, diversion and use of HCPTs has occurred on numerous occasions, and may pose a serious risk. Furthermore, the fall 2001 US anthrax attacks indicate that bioterrorists either possess or have access to relevant scientific expertise. The unusually virulent nature of the strain,[193] as well as the small particle size of the spores and unique coating, were critical factors in the five reported deaths.

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[188] Chikungunya virus is a togavirus that is rarely fatal but causes acute illness that can be incapacitating to humans. There is no treatment currently available.

[189] Philip J. Hilts, "Former Army Researcher Says Quart of Disease Virus Disappeared," *The Washington Post*, September 24, 1986. Hearings before the Subcommittee on Oversight of Government Management of the Committee on Governmental Affairs, United States Senate, 100th Congress, Second Session, July 27–28, 1988.

[190] Hearings before the Subcommittee on Oversight of Government Management of the Committee on Governmental Affairs. United States Senate, 100th Congress, July 27-28, 1988.

[191] Rick Weiss and Joby Warrick, "Army Lost Track of Anthrax Bacteria," *The Washington Post*, January 21, 2002.

[192] Joby Warick, "No One Asked Questions," *The Washington Post*, February 19, 2002.

[193] The strain of *Bacillus anthracis* used in the US *Bacillus anthracis* attacks has been identified as the Ames strain. Virulent forms of *Bacillus anthracis*, such as the Ames strain, carry two large plasmids that contain virulence factors of toxin and capsule production. See Timothy D. Read, Steven L. Salzberg, Mihai Pop, Martin Shumway, Lowell Umayam, Lingxia Jiang, Erik Holtzapple, Joseph D. Busch, Timothy L. Smith, James M. Schupp, Daniel Solomon, Paul Keim, Claire M. Fraser, "Comparative Genome Sequencing for Discovery of Novel Polymorphisms in *Bacillus anthraci*," *Science*, May 9, 2002.

2.2.5 Summary

Based on the historical record of bioterrorism incidents, two broad patterns of bioagent acquisition and biological weapons use emerge: (1) substate actors appear to be more willing than states to use pathogens and toxins to achieve goals and (2) substate actors are more likely than states to use pathogens and toxins that are readily available. While the number of bioterrorism incidents has been growing, mass casualty attacks have not been a part of this new commitment. This does not mean that groups will not try to obtain pathogens or toxins, particularly HCPTs. Indeed, the cases of Aum Shinrikyo and the anthrax attacks of fall 2001 indicate that there may be individual(s) who will use HCPTs. However, the Rajneeshee attack underscores another important element of bioterrorism: different substate actors may pursue bioterrorism for different ends and with different motivations. The Rajneeshees intended to conceal their use of bioterrorism; by contrast, other substate actors have sought to claim responsibility for their actions. This fact highlights the importance of understanding motivations of different groups.

Bioterrorism has not caused mass casualties to date.[194] Nonetheless, bioterrorism has resulted in numerous high consequence events. As the anthrax attacks in the US during the fall of 2001 demonstrated, low-casualty bioterrorism can cause significant economic, social, and political disturbances.

In assessing the likelihood of bioterror attacks, one must first determine whether biological weapons are the weapons of choice for terrorists. The vast majority of terrorist incidents have involved conventional means of attack, such as the use of guns, hijackings, and car and suicide bombs. Although the reasons for the predominance of conventional over biological weapons as the tools of choice for terrorists are unclear, some scholars cite the following self-imposed constraints: (1) the difficulty in coordinating and carrying out the logistics and other organizational hurdles for larger or more technologically complex operations (e.g., the Aum Shinrikyo attempts); (2) the desire for publicity and *not* mass deaths (e.g., the Rajneeshee salmonella poisoning); and (3) the desire not to alienate their members or supporters.[195,196,197] Furthermore, terrorists seem to prefer the instant gratification obtained from using conventional weapons in their attacks. Not only is the effect of a BW delayed, but terrorists may also believe that they will have more control over, and more confidence in, a conventional weapon's effectiveness. Finally, the recent examples of terrorism against the US (e.g., the 9/11 attacks, the USS Cole, the African Embassy bombings, and the Murrah Federal Building bombing) demonstrate a desire to use asymmetrical means to inflict highly symbolic (and emotional) damage. Historically, biological weapons have not been effective in this capacity, but current concerns over bioterrorism may indicate a changing role for biological weapons.

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[194] David Rappaport, "Terrorism and Weapons of the Apocalypse," *National Security Studies Quarterly*, *V*(3):49–67, Summer 1999.

[195] Bruce Hoffman, "Responding to Terrorism Across the Technological Spectrum," *Terrorism and Political Violence*, *6*(3), Autumn 1994.

[196] Walter Laquer, *Terrorism*, London, Weidenfeld and Nicolson, 1977.

[197] Brian Michael Jenkins, "International Terrorism: A New Mode of Conflict," *International Terrorism and World Security*. David Carlton and Carlo Schaerf (Eds.), London, Croom Helm, 1975.

Indeed, in the 1990s, terrorism analysts noted a new form of terrorism emerging, one that was more lethal, indiscriminate, and complex, involving new adversaries, motivations, and methods.[198,199,200] The events of September 11, 2001, as well as the anthrax attacks in the US, have underscored the concern over whether or not incidents of bioterrorism will increase in the future. This question remains unanswered. In addition, there have been unsubstantiated but disturbing reports that samples of smallpox may exist at more than the two approved laboratories in Siberia and Atlanta,[201] as well as experts' assertions that a biological weapons event involving smallpox would have devastating consequences on today's largely unvaccinated populace.[202] Suspicion that particular substate actors—especially al Qaeda—are interested in biological weapons has also fueled concern about the risk of bioterrorism. Rapid advances in bioengineering and biotechnology, growth in the number of high-containment facilities worldwide, consolidation in US and international agricultural business, and a fundamental weakness in biological arms control may persuade states and/or substate actors to pursue bioterrorism and /or biological weapons proliferation. However, it is important to evaluate the technical hurdles a would-be bioterrorist would have to overcome to perpetrate a successful bioterrorism event.

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[198] Steven Simon and Daniel Benjamin, "America and the New Terrorism," *Survival 42*(1), 59–75, Spring 2000.

[199] Bruce Hoffman, *Inside Terrorism*, New York, Columbia University Press, 1998.

[200] Ian O. Lesser, Bruce Hoffman, John Arquilla, David F. Ronfeldt, Michele Zanini, and Brian Michael Jenkins, *Countering the New Terrorism*. Santa Monica, RAND, 1999.

[201]William J. Broad and Judith Miller, "Government Report Says 3 Nations Hide Stocks of Smallpox," *The New York Times*, June 13, 1999.

[202]Tara O'Toole, "Smallpox: An Attack Scenario," *Emerging Infectious Diseases*. *5*, 1999.

3. Technical Hurdles

An understanding of the technical hurdles required to create and deploy biological weapons is necessary to gain a fuller understanding of the biological weapons threat. Typically, successful biological weapon development and deployment require successful navigation of the following technical hurdles: (1) acquisition of a virulent pathogen or toxin; (2) production of the agent; (3) processing of the agent; (4) employing an appropriate delivery form and device; and (5) deploying the agent effectively. [203,204,205] To overcome these technical hurdles requires knowledge, skill, and equipment.

Biological weapons are fundamentally different from both nuclear and chemical weapons in ways that make them a more attractive option to some state and substate actors. First, biological weapons are made up of living microorganisms capable of reproducing within a host. Thus, while nuclear and chemical weapons usually require large amounts of material to be effective, some biological weapons require very small amounts (as the infecting organism(s) may replicate and use the host as a dissemination device following an attack), which in turn demand far less storage capacity. Second, in contrast to both nuclear and chemical weapons materials, biological weapons materials do not require extensive precursor materials and equipment. Third, the processing and manipulation required with chemical and nuclear weapons generally leave traces that are more easily identified than those associated with biological weapons. Fourth, biological weapons agents are dual-use in nature; consequently, traces of biological weapons production cannot be easily differentiated from legitimate biological research or commercial activities. As a result, the ability of microorganisms to reproduce, coupled with their dual-use nature, makes concealment of a clandestine, offensive, biological weapons program relatively easy. Although such factors make biological weapons an attractive alternative to chemical and nuclear weapons, there remain numerous technical hurdles that must be overcome in order to develop an effective weapon.

Scientific expertise is often needed to overcome the technical hurdles to biological weapons development and deployment, making it important to understand what individuals with varying levels of education and expertise would likely be able to accomplish.

A high school biology student could probably culture and grow bacteria as well as provide assistance to a more advanced individual, but would likely be unable to do much more without detailed, specific

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[203] David R. Franz, Cheryl D. Parrott, and Ernest T. Takafuji, "The U.S. Biological Warfare and Biological Defense Program," *Textbook of Military Medicine. Part I. Warfare, Weaponry, and the Casualty: Medical Aspects of Chemical and Biological Warfare*, Falls Church: Office of the Surgeon General, Department of the Army, 1997.

[204] US General Accounting Office, Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks, September 1999.

[205] William C. Patrick III, "Biological Warfare: An Overview," *Proliferation*. Kathleen Bailey (Ed.), Livermore: Lawrence Livermore National Laboratory, 1994.

instructions and oversight. One of the members of the RISE group was a gifted high school student who had formal training in biology. However, he was unable to develop a biological weapon.[206]

A graduate with a two-year degree in a biology-related field could accomplish technical-level work. Individuals from these programs can prepare complex culture media, culture most aerobic and anaerobic gram positive and negative bacteria, culture viruses in eggs, and perform basic testing procedures to identify organisms. Typically, these individuals can assist formally trained scientists with experiments, diagnostic testing, etc. Five years as a technician is considered equivalent to a baccalaureate degree. [207] Larry Wayne Harris was a technician.[208]

A baccalaureate degree in a biology-related program would give the individual a greater background in bacteriology, toxin production, host-parasite interactions, and exposure to virology and mycology. This background would enable the individual to undertake experiments under supervision of a trained scientist. He or she would also be qualified to work in a laboratory. Five years of work experience at the baccalaureate level is considered equivalent to a master's degree.[209]

The next two groups of individuals are the junior scientist (graduate with a master's degree) and the senior scientist (graduate with a Ph.D.). A junior scientist would have had extensive experience in the specialized field of microbiology. A junior scientist could head the microbiology section of a laboratory or work in the pharmaceutical or biotechnology industry, but would still be under some supervision. A junior scientist would be able to fully conceptualize problems in the form of formal hypothesis testing and evaluation. Typically, junior scientists can design, produce, and evaluate their own, original research. They would have full knowledge of pathogens and toxins, including ways to weaponize agents. A senior scientist would be able to perform all the tasks of a junior scientist as well as serve as the head of his or her own laboratory.[210]

However, scientists and engineers do not work alone; rather, they tend to work in teams. These collective human assets—separate from individual skill—become very important in evaluating needed expertise for

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[206] Information on technical expertise needed at various stages of BW research, development, and use comes from: Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002. This report is the result of experts pulled together by the National Defense University and the Monterey Institute for International Studies. A brief summary of this report by Raymond A. Zilinskas is available online at: http://lxmi.mi.infn.it/~landnet/Biosec/zilinskas1.pdf.

[207] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[208] Jessica Stern, "Larry Wayne Harris (1998)," *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker (Ed.), Cambridge, MA, MIT Press, 2000.

[209] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[210] Ibid.

creating biological weapons. A strong set of human assets allows an agency or group to call upon specific expertise in areas related to biological weapons development and use. The full range of human assets includes individuals with backgrounds in microbiology, dissemination methods, and other areas that serve to improve the sophistication and effectiveness of biological weapons. This range of human assets could be met with a group as small as two people, a microbiologist and a physicist or mechanical engineer.[211] Potential sources of these human assets include the employees of the biotechnology sector and unemployed former bioweapons scientists from the FSU. In general, growing numbers of people are receiving increasingly sophisticated technical education and have access to the necessary tools.

A related human asset is tacit knowledge. Tacit knowledge involves the knowledge embedded in learning how to perform various tasks (e.g., thumping a cantaloupe to test for ripeness). While oral and written instructions may help to introduce the desired skill, to achieve mastery each individual must "learn by doing" and "learn by example." In more formal terms, tacit scientific knowledge can be defined as, "knowledge or abilities that can be passed between scientists by personal contact, but cannot be, or has not been, set out or passed in formulae diagrams, or verbal descriptions and instructions for action."[212] Tacit knowledge is usually a local phenomenon embodied in small groups of people who communicate this understanding by direct, personal interaction.[213,214]

Although the number of documented bioterrorism incidents has been increasing over the last century, the historical record shows that it has been difficult for groups to assemble the scientific expertise and materials necessary to develop a biological weapon that results in a high consequence event. Nonetheless, there has been a great deal of debate over whether or not a future incident will result in a high consequence event. The Aum Shinrikyo incident illustrates one side of the argument. Aum Shinrikyo acquired an avirulent strain of anthrax.[215,216] It is unknown as to why they acquired an avirulent strain. The failure to acquire or develop a virulent strain came about despite the organization's substantial funding, employment of several scientists with advanced degrees in biochemistry and microbiology, and

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[211] Richard Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer. *America's Achilles Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, Cambridge, MA: MIT Press, 1998.

[212] H. M. Collins, "Tacit Knowledge, Trust, and the Q Sapphire," *Social Studies of Science*, *31*(1), 2001.

[213] Eugene S. Ferguson, "The Mind's Eye: Nonverbal Thought in Technology," *Science*, *197*(4306), August 26, 1977.

[214] Kathleen Jordan and Michael Lynch, "The Sociology of a Genetic Engineering Technique: Ritual and Rationality in the Performance of the 'Plasmid Prep'" *The Right Tools for the Job: At Work in Twentieth Century Life Sciences*, Adele E. Clarke and Joan H. Fujimura (Eds), Princeton, NJ, Princeton University Press, 1992.

[215] Kyle B. Olson, "Aum Shinrikyo: Once and Future Threat?" *Emerging Infectious Diseases*. *5*(4), July/August 2000.

[216] W. J. Broad, S. Wu Dunn, and Judith Miller, "How Japan Germ Terror Alerted World," *The New York Times*, May 26, 1998.

the creation of a sophisticated biological research facility.[217,218] Additionally, the cult's biological research facility never attracted the attention of the Japanese or other governments, allowing them to work without government intervention. Some have argued that if the well-funded, expert scientists working unimpeded for Aum Shinrikyo were unable to effectively create and disseminate infectious pathogens, it is not likely that terrorist organizations with fewer resources and less expertise could undertake a large-scale biological or chemical attack.[219,220] Others argue that this group, which came remarkably close to producing a high consequence biological weapon, demonstrates the severity of the bioterrorist threat.

Those who consider the threat of a high consequence event to be severe often cite the significant physical damage and long term economic impacts resulting from the fall 2001 anthrax attacks. The economic impacts include not only the expense of the extensive decontamination procedures, but also the untold cost associated with placing tens of thousands of citizens on prophylaxis antibiotic treatment to prevent anthrax infection. In addition, the fall 2001 anthrax attacks indicated that there are individual(s) who either have expertise or have access to that expertise, as well as the determination to use HCPTs.

3.1 Acquisition of a Virulent Pathogen or Toxin

The first step in creating a biological weapon is the acquisition of a virulent pathogen or toxin. While this may seem obvious, the process can be complicated. Some even claim that the acquisition of a virulent strain is the rate-limiting step.[221] For example, Aum Shinrikyo was unable to obtain a virulent strain of anthrax. Although strains of a particular pathogen may be immunologically similar, they can vary widely in terms of pathogenicity, lethality, transmission rates, environmental susceptibility, as well as other factors. The ability to correctly identify whether a particular pathogen is virulent or avirulent is a necessary technical skill. The literature facilitates the identification process as it readily identifies pathogenic strains in terms of the above characteristics, including virulence. In addition to virulence, ten specific characteristics of a pathogen or toxin need to be evaluated depending on the type of biological weapon the state or substate actor hopes to produce. While each characteristic need not be optimal in order to result in successful biological weapons production, state programs have generally considered all ten in selecting agents for biological weapons production. The characteristics are as follows: (1) availability; (2) infectivity; (3) pathogenicity; (4) lethality; (5) transmissibility; (6) amplification; (7) processing; (8) the availability of countermeasures or population immunity; (9) environmental hardiness; and, (10) the ability to camouflage itself as an endemic or common disease.

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[217] Barry Kellman, "Biological Terrorism: Legal Measures for Preventing Catastrophe," *Harvard Journal of Law and Policy. 24*(471), Spring 2001.

[218] Jessica Stern, *The Ultimate Terrorists*. Cambridge, MA, Harvard University Press, 1999.

[219] Kyle B. Olson, "Aum Shinrikyo: Once and Future Threat?" *Emerging Infectious Diseases*, *5*(4), July/August 2000.

[220] Jonathan B. Tucker, "Bioterrorism is the Least of Our Worries," *The New York Times*, October 16, 1999.

[221] Amy E. Smithson and Leslie-Anne Levy, "Ataxia: The Chemical and Biological Terrorism Threat and the US Response." Washington, D.C.: The Henry L. Stimson Center, 1999.

3.1.1 Availability

Most pathogens and toxins are available from a variety of sources. The first possible source is from nature. Human, animal, and plant disease outbreaks occur naturally throughout the world. These outbreaks are generally reported in a variety of trade and news publications as well as publicly available Internet disease surveillance systems such as ProMED.[222] Consequently, a bioweaponeer could go to the location of an outbreak to collect the responsible pathogen or toxin. However, pathogens and toxins also exist in nature at sub-outbreak thresholds. The most notable example is anthrax. While information on anthrax, including location, types of animals afflicted, and general information on the strain,[223] is widely available in public libraries, obtaining a viable sample is not as easy. A trained microbiologist would be needed to identify and isolate the material. This skill set would not be available to an untrained individual nor would it be easily mastered by reading a textbook on the subject. For example, the group Dark Harvest attempted to simply use soil from Gruinard Island as a biological weapon. Although the soil contained anthrax, it contained the pathogen in such a low concentration that this bioterrorism attack was ineffective.[224] Therefore, not only must the bioweaponeer be able to cultivate the sample from nature, but he/she must be able to overcome the enormous hurdle of time and effort required to sort through all of the strains of a particular pathogen found in nature, finding a suitable choice. For example, the time and effort required to find a suitably pathogenic strain in the approximately 675 strains of *Clostridium botulinum* found in nature would be considerable.[225]

Microbial culture collections—both domestic and foreign—are a second source of pathogens and toxins. Before the passage of the Antiterrorism and Effective Death Penalty Act in 1996, pathogen acquisition from microbial culture collections in the United States was not closely monitored. For example, the American Type Culture Collection (ATCC) sold culture strains to Iraq in the 1980s. ATCC is a large clearinghouse that ships pathogens, requiring biological safety precautions to both domestic and international entities. Many of these pathogens are attenuated, avirulent strains, and could not be used directly as a biological weapon; however, they do provide valuable information for research and development programs. It should be noted that ATTC no longer ships "select agents"[226] to any person or facility.

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[222] Program for Monitoring Emerging Infectious Diseases (ProMED). http://www.fas.org/promed/

[223] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[224] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit use of Biological Agents Since 1900*. Center for Counterproliferation Research, Washington, DC, National Defense University, August 1998 (Revised February 2001).

[225] Amy E. Smithson and Leslie-Anne Levy, "Ataxia: The Chemical and Biological Terrorism Threat and the US Response." Washington, D.C.: The Henry L. Stimson Center, 1999.

[226] Listed in 7CFR 33.1, 9CFR 121.3, 42CFR 73.4

Foreign microbial collections, another source of pathogens and toxins, present a greater risk for acquisition; ATCC estimates there could be as many as 450 global collections.[227] Some of these global facilities belong to larger networks. For example, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) supports the Microbiological Resource Centers Network (MIRCEN). The network comprises 31 cultural collection centers in 25 nations.[228] These facilities require some type of evidence that the person requesting a sample is, in fact, who they say they are and are associated with a credible facility. Although certification of proper credentials is now standard in the US, an individual who is legitimately employed at a facility could still acquire a pathogen or toxin for nefarious purposes. Standards for global acquisition from culture collections do not currently exist.[229] Furthermore, consideration must be given to accommodating the necessary and standard research practice of laboratories sharing and transferring their research samples, enabling other laboratories to reproduce and build on their results.

Laboratories and other research or clinical facilities are a third potential source of pathogens and toxins. Facilities include microbiology laboratories, hospitals, clinics, university laboratories, etc. In addition to those facilities within the US, there are numerous facilities overseas – including the FSU. The FSU is of particular concern because of the extensive Soviet biological weapons program. The program weaponized a variety of agents in numerous facilities collectively housed under Biopreparat. There is considerable concern that these materials may not be adequately protected. Security in the FSU is far below accepted security standards in the US. Additionally, FSU scientists and engineers receive subsistence salaries. This creates a two-fold risk: (1) facilities that can be easily accessed by adversaries who wish to steal pathogens or toxins, and (2) individuals who have legitimate access to pathogens or toxins who may be willing to remove material for monetary gain.[230]

3.1.2 Infectivity

Infectivity is the capability of a pathogen or toxin to enter, survive in, and multiply in a susceptible host. Infectivity measures the number of organisms required to cause disease in a host, but does not necessarily translate to increased morbidity or mortality. High infectivity means fewer organisms are required to cause disease.[231] For example, *Francisella tularensis* is highly infectious: as few as 10 organisms can

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[227] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[228] Edgar J. DaSilva, *MIRCEN: Microbiological Resource Center*, Paris, United Nations Scientific, Educational, and Cultural Organization, 1997.

[229] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[230] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[231] "Chapter 1: Introduction." *FM 8-9: NATO Handbook on the Medical Aspects of NBC Defensive Operations AMedP-6(B): Part II Biological*, Departments of the Army, the Navy, and the Air Force (no date). http://www.vnh.org/MedAspNBCDef/2ch1.htm

cause tularemia after a 3-5 day incubation period. If left untreated, tularemia has a mortality rate of 30-60%. On the other hand, *Brucella suis*, also highly infectious, has a mortality rate of about 2%.[232]

The infectivity of anthrax is largely dependent on the manner in which bacteria comes into contact with a host [through the skin (cutaneous), by ingestion (gastrointestinal), or by inhalation into the lungs (inhalational)]. Anthrax is a bacterium that releases three dangerous toxins after entering an organism. Although anthrax has caused disease in animals throughout the world for centuries, the disease is uncommon among humans.[233] Anthrax is most often found in herbivores that become infected by ingesting spores from the soil. There have been large outbreaks of anthrax in herbivores, such as a 1945 anthrax epidemic in sheep in Iran resulting in one million sheep deaths;[234] however, large-scale animal vaccination programs have dramatically reduced animal mortality.[235]

Infectivity can be increased through manipulation. Pathogens use hydrolytic (water splitting) enzymes to damage or destroy proteins and lipids, the components of cellular membranes and walls. Increased infectivity can be achieved by enhancing production of these hydrolytic enzymes, or other enzymes that allow the pathogen to circumvent the hosts' antibody system, or proteins that build receptors specific to the host cell being attacked; any of these mechanisms would be effective. A skilled biological weapons scientist may attempt to enhance the infectivity of any given organism in these or conceptually similar ways; however, only an advanced microbiologist would likely be able to achieve this level of manipulation.[236]

3.1.3 Pathogenicity

Pathogenicity refers to the ability of a pathogen to inflict damage (i.e., disease) upon its host. Pathogenicity is displayed through virulence, which is a measure of the degree of pathogenicity. The mechanisms by which pathogens cause disease include their ability to invade a host organism (invasiveness) and their ability to produce toxins. As with infectivity, a biological weapons scientist may be able to increase pathogenicity by modifying the various characteristics of an organism.[237]

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[232] US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, Washington, DC, US Government Printing House, December 1993.

[233] D. Lew, "*Bacillus anthracis* (anthrax). *Principles and Practices of Infectious Diseases*, G. L. Mandell, J. E. Bennett, and R. Dolin (Eds), New York, NY, Churchill Livingstone, Inc., 1995.

[234] E. Kohout, A. Sehat, and M. Ashraf, "Anthrax: A Continuous Problem in South West Iran," *American Journal of Medical Science*, 1964.

[235] U. V. Pienaar, "Epidemiology of Anthrax in Wild Animals and the Control on Anthrax Epizootics in the Kruger National Park, South Africa," *Federation Proceedings, 26,* 1967.

[236] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[237] Ibid.

Invasiveness includes not only the pathogen's ability to invade and colonize a host, but also its ability to overcome host protections and produce extracellular substances that facilitate invasion. When a pathogen first enters a host, it must establish a colony. Part of this colonization includes bacterial adherence (or attachment) to a cell or tissue surface. Invasins (proteins) are extracellular molecules that aid in breaking down host defenses against the pathogen. They act to damage host cells so that the pathogen may invade.[238] Toxigenesis (the ability to produce toxins) includes the ability to produce both endotoxins (cell-associated substances that are part of the cell structure) and exotoxins (released from cells). Endotoxins act locally while exotoxins may damage cells that are removed for the area of infection.[239]

The host has a number of defenses associated with the immune system to protect itself from pathogens. The immune system is a set of inter-connected systems that identifies foreign bodies. Part of this system is the phagocytic process, or generalized immune response, which identifies and engulfs foreign invaders.[240] Pathogens may be able to overcome these defenses by avoiding contact with a phagocyte, avoiding engulfment, and avoiding digestion. Some bacteria, like *Bacillus anthracis*, are able to overcome some host protections. *Bacillus anthracis* is able to sporulate—a possible mechanism of avoiding destruction by the host's phagocytes.[241]

3.1.4 Lethality

The lethality of a pathogen or toxin refers to how likely its resultant disease will cause the death of its host.

3.1.5 Transmissibility

Transmissibility describes a pathogens' ability to be conducted from one host to another, or a pathogens' relative contagiousness.[242] In addition to direct host-to-host transmission, such as through the air, pathogens may spread indirectly through a vector, such as a mosquito or flea.[243]

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[238] Kenneth Todar, *The Mechanisms of Bacterial Pathogenicity*, Department of Bacteriology, University of Wisconsin-Madison, 2002. http://www.bact.wisc.edu/Bact303/Bact303pathogenesis

[239] Ibid.

[240] Phillipe Chavrier, "May the Force Be With You: Myosin-X in Phagocytosis," *Nature Cell Biology*. *4*(7), July 2002. http://www.nature.com/cgi-taf/DynaPage.taf?file=/ncb/journal/v4/n7/full/ncb0702-e169.html

[241] Kenneth Todar, *The Mechanisms of Bacterial Pathogenicity*, Department of Bacteriology, University of Wisconsin-Madison, 2002. http://www.bact.wisc.edu/Bact303/Bact303pathogenesis

[242] Ibid.

[243] "Chapter 1: Introduction," *FM 8-9: NATO Handbook on the Medical Aspects of NBC Defensive Operations AMedP-6(B, Part II Biological*, Departments of the Army, the Navy, and the Air Force, (no date). http://www.vnh.org/MedAspNBCDef/2ch1.htm

3.1.6 Amplification

Amplification or production is the culturing of a pathogen to grow the quantity of a pathogen or toxin. Different types of pathogens require different media in which to multiply. The material can be amplified more easily if the pathogen grows quickly (as an agent itself or the source of toxin), the nature of growth media is unsophisticated, and the required level of technical expertise is low. Additionally, while many agents can live outside of a host, viral agents cannot. Consequently, these types of agents would need additional manipulation to keep them viable during this amplification process. Larger quantities of material provide an adversary with more opportunities to infect a population [See Section 3.2] but, only small quantities of biological agents, capable of undergoing amplification, are necessary as starting material. Not only may an organism be amplified externally to provide enough material to spread widely, but as mentioned in Section 3.1.2, the ability of an organism to undergo amplification in its host is a key factor in determining infectivity, i.e. how much material would be required to adequately infect each host.

3.1.7 Processing

Processing refers to the degree to which a pathogen or toxin must be manipulated to facilitate dispersal. The material is processed to accomplish three specific events: (1) to resist environmental stressors, (2) to survive dissemination, and (3) to increase the pathogen or toxin infectivity and/or pathogenicity. [See also Section 3.3] If high levels of processing are required to make an effective weapon, potential technical difficulties with the processing may render the biological materials useless as a weapon (e.g., imperfect particulate size may not be pathogenic).

3.1.8 Available Countermeasures and/or Immunity

Easily available countermeasures or high levels of immunity in the population directly impacts the effectiveness of a biological weapon. Available countermeasures include vaccines, antibiotics, and other types of prophylaxis and therapeutic treatments that could be used to reduce the affect of a biological weapons attack and/or protect individuals involved in pathogen or toxin manipulation from becoming infected themselves. However, different types of agents require different forms of intervention. Bacteria are living organisms that reproduce by simple cell division. Most bacteria are susceptible to specific therapy with antibiotics. By contrast, viruses reproduce only within living cells of a host organism. The diseases they produce generally do not respond to antibiotic treatment; however, antiviral therapies are available for certain types of viral infections. Vaccines may also protect an individual from the onslaught of viral disease. Rickettsiae are microorganisms that have characteristics similar to both bacteria (they require oxygen to live) and viruses (they require other living cells for growth). They are susceptible to broad spectrum antibiotics. Fungi are plants that do not use photosynthesis and are capable of anaerobic growth. Fungi tend to respond to antimicrobial intervention. Finally, toxins are produced by and derived from living plants, animals, and microorganisms. Certain toxins may also be produced by chemical means. Antisera and selected pharmacological agents can counter the effects of these poisons.[244]

In addition to medical intervention, other types of countermeasures are available to prevent the outbreak of disease. Universal health precautions involve a number of different barrier protections. These

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[244] Ibid.

protections, while not necessarily destroying the pathogen or toxin, limit their ability to contaminate a susceptible host. Barriers include gloves, masks, gowns, aprons, and goggles. Additionally, simple disinfectants used to sterilize surfaces can prevent infection. An example of the importance of universal health precautions involves the disease Ebola. Ebola is a hemorrhagic fever first recognized in 1976. The reservoir, the passive carrier, for Ebola is currently unknown. First seen in Zaire, now the Democratic Republic of the Congo, Ebola causes its victims to bleed profusely leading, in most cases, to death. Traditional burial practices in Zaire called upon family members to retrieve a loved one following death and bathe him or her. Unprotected contact by the family member with deceased's blood often resulted in new infection. Implementing barrier measures as well as simple disinfectant regimes dramatically cut the rate of infection.[245,246] Finally, respirators and biosafety-rated protective suits provide additional countermeasures. These types of equipment give the wearer a self-contained environment and prevent exposure to a particular pathogen or toxin. This type of equipment is generally not available to the public.

Pathogens and toxins that are susceptible to these types of countermeasures will have less impact than those pathogens and toxins for which there are no known, well-developed or widely available treatments. State programs have traditionally pursued those pathogens or toxins that are susceptible to countermeasures because states generally have an obligation to protect their own citizenry. In the event of a biological attack, pathogens or toxins could easily "blow back" to their state of origin; they could also spread to other unintended, undesired targets. Substate actors, however, generally have different motivations, and may not take into consideration available countermeasures. However, both the Rajneeshee attack and the fall 2001 anthrax attacks used pathogens (*Salmonella typhi* and *Bacillus anthracis*) that could be treated with medical intervention.

3.1.9 Environmental Hardiness

Environmental hardiness is the ability of an individual pathogen or toxin ability to survive outside of a host. For example, anthrax is very hardy; it can survive for 20 years or longer outside of a host organism because of its ability to sporulate.[247] By contrast, some viruses are particularly sensitive to heat and ultraviolet light and may not survive long outside of a host organism. Viral agents can only reproduce inside living cells and, therefore, need to be stabilized after production in order to prevent (or slow down) degradation. Relative hardiness may serve to increase probability of use, not only because it leads to continued exposure and illness, but because it increases the likelihood of successful deployment.

The environmental hardiness of an agent determines the storage and dissemination procedures that must be used if it is to be deployed as a weapon. While storage may only involve monitoring temperature and protecting against light sources, the requirements may be much more extensive, and these two factors alone may necessitate large investments in equipment. This equipment, in turn, may impact the manner in

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[245] Center for Disease Control and Prevention, "Ebola Hemorrhagic Fever," *Special Pathogens Branch*, http://www.cdc.gov/ncidod/dvrd/spb/mnpages/dispages/ebola.htm

[246] Laurie Garrett, Betrayal of Trust: The Collapse of Global Public Health, New York, NY: Hyperion, 2000.

[247] US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, Washington, DC, US Government Printing House, December 1993.

which the material can be transported. Storage and transportation containers must not leak or degrade the virulence or viability of the pathogen of toxin. Susceptibility to natural elements during dissemination also presents unique problems for maintaining the virulence or viability of a pathogen or toxin. Many viral agents are degraded or destroyed by light or heat; consequently, they could not be effectively disseminated with a missile or explosives, or even during daylight hours. Along with the technical difficulties in identifying and harvesting any given pathogen or toxin, a secondary skill set must be developed in order to store and disseminate the pathogen or toxin in such a way that it does not degrade the agent's ability to be an effective weapon.

3.1.10 Ability to be Camouflaged

The extent to which a biological attack can be camouflaged to present as an endemic or common disease outbreak may be considered an important attribute. Pathogens and toxins that can be camouflaged are generally more attractive agents because they would discourage immediate attribution and improve the perpetrator's chances of escaping undetected. However, some substate actors may want to receive credit and notoriety for successfully deploying a biological weapon.

3.2 Production of Material

Once a pathogen or toxin has been chosen, the quantity used becomes an important factor. As described in Section 3.1.2, large amounts of material may be required for reliable infectivity upon dissemination. Therefore, it is desired to be able to calculate how much material is needed to injure or kill the desired number of individuals. Moreover, such calculations also need to factor in the anticipated die-off rate for the pathogen (i.e., how many organisms would likely succumb to environmental stressors) as well as predict how much of the organism would likely come into contact with members of the target population.

Material production to increase the quantities of pathogen is often the simplest step. Once the biological agent has been chosen based on the preceding ten characteristics, a seed culture must be obtained by one or more of the mechanisms detailed in Section 3.1.1. This seed culture is then injected into a flask or fermenter containing appropriate growth media. Different types of pathogens and toxins require different media in which to multiply. While most bacteriological agents can survive outside of a host, viral agents cannot; consequently, viruses require additional manipulation. However the necessary recipes, supplies, and equipment are all easy to obtain and many of these items may be obtained in pre-packaged "kits". At all times, agents are susceptible to environmental degradation, requiring special precautions be taken to preserve the integrity of the agents during this process. Additionally, during this amplification process, the technician needs to watch for contaminants or genetic mutations that could weaken the biological agent. [248]

[248] Amy E. Smithson and Leslie-Anne Levy, "Ataxia: The Chemical and Biological Terrorism Threat and the US Response." Washington, D.C.: The Henry L. Stimson Center, 1999.

3.3 Processing of Material

Material is processed to accomplish three goals: (1) to resist environmental stressors; (2) to survive dissemination; and (3) to increase the pathogen or toxin infectivity and/or pathogenicity.

As discussed throughout Section 3, pathogens and toxins are susceptible to environmental degradation. Different pathogens and toxins, however, may be more susceptible to different types of environmental stressors. For example, viral agents are more susceptible to ultraviolet light than are bacterial agents. Consequently, in order to process a pathogen or toxin for eventual use as a biological weapon, a level of expertise with the particular material identified for use must be present. This expertise would be needed to both grow and store material without losing virulence.

The second type of processing involves manipulating the material to survive dissemination. This step would require expertise on not only the particular pathogen or toxin, but also on dissemination methods. Not all dissemination methods are viable for any pathogen or toxin. Anthrax is generally not susceptible to most environmental stressors; however, in order to have the most effective impact on a target population, it should be processed to a small enough sporulate that it can easily be inhaled and lodged in the victim's respiratory tract. This particular type of skill requires knowledge and experience in aerosol technology. Successful dissemination would also be aided by experience in overcoming electrostatic attraction to prevent clumping and microencapsulation of the agent to decrease its environmental susceptibility.

The level of processing depends on the state of the pathogenic material. Liquid agents are easy to produce. The only further processing required after amplification might include the addition of stabilizers. The creation of dry agents requires the produced material to be either spray dried or freeze dried (lyophilized) and then milled to achieve the optimal particle size for inducing pulmonary infections. As preeminent former US bioweaponeer William Patrick recognized, liquid agents are easy to produce but are more difficult to successfully disseminate while dry agents are more difficult to produce but are relatively easy to disseminate. [249] As discussed below (Section 3.4), dry and liquid agents are suitable for crude dissemination and both can be aerosolized. Dry agents are typically more robust and likely to survive the aerosolization process.

Finally, processing material to increase a pathogen's or toxin's infectivity and/or pathogenicity requires a highly specialized expertise that combines knowledge of a particular pathogen or toxin with knowledge of genetics and DNA processes. In order to increase aspects of a pathogen's or toxin's DNA profile, an individual would need to know not only what particular part of the DNA strand needs to be modified, but also how to modify it. This may involve the use of specialized equipment (such as a DNA splicer) that would likely be available only to well-funded organizations.

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[249] William C. Patrick, III, "Biological Terrorism and Aerosol Dissemination," *Politics and the Life Sciences* 15(2) September 1996.

3.4 Employing a Delivery Form and Device

Dissemination is the process of spreading a pathogen or toxin to cause infection. Similar to natural outbreaks of disease, intentional outbreaks rely on the same pathways for infection: inhalation, ingestion, or percutaneous inoculation.[250] Methods for dissemination range from crude to sophisticated. The two successful bioterrorist attacks in the US both used crude dissemination methods. In the first case, the Rajneeshee cult simply placed samples of salmonella on salad bars. In the second case, an unknown actor or actors mailed weaponized anthrax in envelopes. Neither agent was particularly susceptible to the environment. Additionally, neither attack resulted in a mass casualty event. A future act of bioterrorism, using a different dissemination method could produce more catastrophic results than either of these two events.

3.4.1 Inhalation via Aerosolization

Inhalation of a pathogen or toxin requires it be aerosolized; both liquid and dry agents can be aerosolized. However, the mechanical stresses inherent in the aerosolization process of liquid slurrys can destroy most of the pathogen.[251] A biological weapon delivery system that relies on aerosolization would likely aim to disseminate particulates 10 microns or less in diameter. Smaller particles can remain airborne for longer periods of time than larger particles. However, a diameter of less than 0.5 microns tends to result in unstable particles that are more susceptible to environmental degradation. The upper respiratory tract can become infected with particles as large as 20 microns, but these larger particles are more likely to be filtered out by natural processes. Experts generally agree that inhalation infection requires far fewer organisms than ingestion or percutaneous inoculation.[252] There is widespread disagreement in the literature regarding the possible success of a biological attack using low technology methods for aerosol generation (e.g. hand-held spray cans, truck-mounted sprayers).[253] The underlying issue is a disagreement on how successful an attack could be that relies on a dissemination technique with a lower yield of aerosolized particles within the optimal size range. Access to higher technology methods may become more prevalent as the pharmaceutical industry actively researches and develops methods for the aerosol delivery of medical drugs. This provides a pool of knowledge and equipment that could potentially be used for the aerosol delivery of pathogens.

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[250] "Chapter 1: Introduction." *FM 8-9: NATO Handbook on the Medical Aspects of NBC Defensive Operations AMedP-6(B): Part II Biological*. Departments of the Army, the Navy, and the Air Force, (no date). http://www.vnh.org/MedAspNBCDef/2ch1.htm

[251] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit use of Biological Agents Since 1900*. Center for Counterproliferation Research, Washington, DC, National Defense University, August 1998 (Revised February 2001). p. 23.

[252] "Chapter 1: Introduction." *FM 8-9: NATO Handbook on the Medical Aspects of NBC Defensive Operations AMedP-6(B): Part II Biological*. Departments of the Army, the Navy, and the Air Force, (no date). http://www.vnh.org/MedAspNBCDef/2ch1.htm

[253] Amy E. Smithson and Leslie-Anne Levy, "Ataxia: The Chemical and Biological Terrorism Threat and the US Response." (Washington, D.C.: The Henry L. Stimson Center, 1999), p. 53-54.

The methods for aerosol dispersal may affect the effectiveness of a pathogen as a weapon. There are three general types of dispersal: (1) point-source dispersal, (2) multiple-point-source dispersal, and (3) line-source dispersal.

Point-source dispersal involves the release of a pathogen or toxin from a stationary source (e.g., bomblets, artillery shells, a suitcase). Point-source dispersal may be either indoors (e.g., into a closed-air system) or outdoors. Aum Shinrikyo used point-source dispersal; however, they were unable to harvest a virulent strain of *Bacillus anthracis* and thus failed to deploy a successful weapon.[254]

Multiple-point-source dispersal uses the same techniques as point-source dispersal but has multiple release points. Aum Shinrikyo also carried out crude multiple-point-source dispersal using briefcases equipped with small fans and tanks of pathogens for dispersal.

Line-source dispersal involves a prolonged release of a pathogen or toxin from a source that is in motion. Aum Shinrikyo attempted this type of dissemination as well, using both *Bacillus anthracis* and *Clostridium botulinum*. The bacteria were not properly processed for aerosolized dissemination; consequently, the nozzle of the sprayer became clogged. In order for this type of device to be effective, the spore must be small enough to easily pass through a nozzle. The cult was unable to grow *Clostridium botulinum* (although they believed that they had). They did disperse something, but not their intended pathogen. This requires knowledge of spray devices and a specialized skill set that enables agent manipulation. The spray device can be used from an airplane (such as a crop duster) or another type of ground transportation.[255]

Aerosolized agents may be more susceptible to environmental degradation than agents designed for ingestion or percutaneous inoculation and aerosolized biological weapons have the potential for a delayed reaction. To address the problem of environmental degradation, infectious agents may be processed to survive outside of a host or outside of ideal storage situations for long periods of time. Such an agent would be able to re-infect host organisms under certain conditions. The Sverdlosk incident of 1979 (discussed in Section 2.1.2) provides a good example of this phenomenon. After the initial accidental release of processed anthrax, the Sverdlovsk Communist party leader, Boris Yeltsin, ordered a clean-up of the city. This inadvertently caused spores that had settled in cracks in the street and other hidden areas to be stirred back into the air again, causing more casualties. The outbreak lasted approximately six weeks before the final victim was diagnosed. [256,257]

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[254] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[255] Ibid.

[256] Alex Neifert, "Case Study: Sverdlovsk Anthrax Outbreak of 1979," *Report to the Camber Corporation*, 2000. http://www.nbc-med.org/SiteContent/MedRef/OnlineRef/CaseStudies/ cssverdlovsk. html

[257] Jan Guillemin, *Anthrax: The Investigation of a Deadly Outbreak*, University of California Press, 1999.

3.4.2 Ingestion

A biological weapon also can be designed to cause infection through ingestion. This dissemination method would involve contaminating food, water, or medical supplies. This type of dissemination is similar to early biological weapons use, and it is primarily a method of sabotage. The Ranjneeshee cult deployed its biological weapon—*Salmonella typhi*—to cause infection through ingestion.

Some commentators have suggested that municipal water supplies are at high risk of contamination by a biological weapon. But many biological weapons experts have argued that filtration, chlorination, and dilution processes, combined with the large numbers of organisms required to cause infection through ingestion, make the contamination of the municipal water system a low-probability, low consequence event.[258]

3.4.3 Percutaneous Inoculation

A biological weapon also can be designed to cause infection through percutaneous inoculation. This dissemination method would aim to infect by dermal exposure. While intact skin provides most hosts with adequate protection against most biological agents, damaged skin or mucous membranes constitute weaknesses that may allow pathogen penetration.[259] Because large areas of damaged skin are rare, percutaneous inoculation usually results in limited, non-lethal exposure. The victims of cutaneous anthrax from the fall 2001 attacks in the United States were treated and successfully recovered from the disease. It is extremely unlikely that a biological weapon, disseminated to cause infection through percutaneous inoculation, could cause a high casualty event.

3.4.4 Other Dissemination Methods

Although the three prime routes of infection are inhalation, ingestion, and percutaneous inoculation, biological weapons programs have researched other types of dissemination methods. Of particular interest is the use of vectors. Vectors are other organisms that carry pathogens to their host. A small sample of known vectors include the flea (plague), mosquito (yellow fever and malaria), and mice (hantavirus). It is theoretically possible to purposively introduce a pathogen into a targeted population via one of a number of vectors; however, this method would require an additional skill set, such as expertise in the field of entomology.

Other methods of dissemination include purposively infecting an individual who would then spread the disease to others. However, this would not be an effective method for all diseases. This would be effective with diseases such as influenza, which is contagious during its prodromal stage, when an individual is

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[258] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[259] Jan Guillemin, *Anthrax: The Investigation of a Deadly Outbreak*, University of California Press, 1999.

contagious, but not showing any symptoms. By contrast, smallpox is only contagious after the characteristic rash appears; however, by that time the infected individual is virtually bed-ridden.[260]

Finally, directly injecting the pathogen or toxin into a targeted victim would also be a possible dissemination method. In 1978, a Bulgarian dissident was assassinated when ricin was directly injected into him. It is highly unlikely that this method would result in mass casualties.

3.4.5 Environmental Considerations

Once a biological weapon is dispersed, weather conditions play an important role in distributing the agent widely. Weather conditions may also hinder the agent's effectiveness. Factors such as relative humidity, temperature, altitude, sunlight, wind, and the inversion layer can impact the effective dissemination, viability, and virulence of any pathogen or toxin. Additionally, each pathogen or toxin has its own environmental susceptibilities and sensitivities. Consequently, knowledge of one pathogen and its susceptibility to environmental stressors does not translate into knowledge of other pathogens.[261]

If a biological weapon is to be deployed outside, individuals with knowledge of meteorology would be necessary to ensure precise dispersal. Weather patterns vary not only from location to location (horizontally), but also from altitude to altitude (vertically). Consequently, the ability to identify appropriate weather conditions and advise those involved in the processing of material as to where the agent is most likely to hit —and how many organisms are likely to survive—is essential.

Attempts to deploy a pathogen or toxin in a closed environment, such as a subway system, eliminates some of the meteorological issues but create a different set of possible problems. To optimally deploy indoors requires an extensive knowledge of not only forced, or closed, air systems, but also extensive knowledge of the type of system a specific target uses. Additionally, knowledge regarding possible filtration systems, air flow patterns, and maintenance schedules may be required in order to advise the processors of biological weapons how to create a weapon to overcome these obstacles. Covert indoor deployment of a biological agent may be able to partially compensate for these difficulties because the confined space can create prolonged exposure times.

3.5 Other Factors

Other factors to consider when evaluating the technical requirements for a state or substate actor to successfully deploy a biological weapon include: (1) facilities and equipment, (2) whether or not field testing will be undertaken before dissemination, and (3) whether or not advanced biotechnology skills are required. In general, each of these factors is important to each of the above outlined steps.

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[260] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[261] Ibid.

Facilities and equipment range from the "basement lab" to advanced, state-run research facilities. Both require minimal investment in basic equipment (e.g., flasks, vials, incubators, burners, and culture media). This type of equipment is not regulated; therefore, purchasing this equipment as an individual (and not through a facility) would not raise any suspicions. With this basic equipment an individual could grow certain types of pathogens or toxins. To culture a virus, embryonated eggs or cell cultures and a minimum level of scientific knowledge are required. More advanced pathogen or toxin manipulation would require more sophisticated research facilities and equipment. For example, if the goal were development of a crude liquid formulation of anthrax as a biological weapon, the basic equipment listed above would suffice. However, development of a more sophisticated dry agent would require drying and milling equipment as well as the ability to operate this equipment. Thus, more complicated pathogen or toxin manipulation requires more investment in equipment, facilities, and expertise.[262] Any state with a vaccine plant is equipped to manufacture bioweapons. Cost estimates for a full suite of laboratory and production equipment range from $2 million to less than $200,000.[263] Kathleen Bailey, a national security analyst, estimates that a minimal bioterrorist facility could be constructed, and be successful, with $10,000 in equipment and fit within a room that measured 15 x 15 feet.[264] Moreover, with the worldwide spread of biotechnology, these costs can be expected to continually decrease.

Field testing is probably most relevant to state programs. Prior to making a weapon —any weapon — available for military use, most states would likely undertake a series of field tests to identify the weapon's overall efficacy. Field tests are important in the world of biological weapons because environmental factors can easily undermine these weapons. Additionally, loading biological weapons into munitions creates operational problems. Putting together a field test under probable attack conditions requires not only a background with biological weapons but also, in all likelihood, a background in military tactics, meteorology, and conventional weapons.[265] Substate actors may be willing to use their first deployment as a substitute for more rigorous pre-trial field testing.

Advanced biotechnology encompasses advances in DNA technologies, genetics, protein and nucleic acids sequencing, functional genomic, genetic, and protein engineering, and cell and tissue culturing. Each of these areas requires further specialization involving individuals, equipment, and facilities. Biological weapons using advanced biotechnology techniques are more likely to be pursued by state programs than substate actors.[266]

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[262] Ibid.

[263] US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, Washington, DC, US Government Printing House, December 1993. p. 86.

[264] Richard Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer. *America's Achilles Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, Cambridge, MA: MIT Press, 1998.

[265] Ibid.

[266] Ibid.

3.6 Summary

The historical record shows that states and well-funded, scientifically competent terrorist groups have encountered difficulties in one or more of the steps for BW production and use. [267] Although these hurdles are not insurmountable, they do provide some measure of deterrence.

In particular, obtaining a pathogen or toxin does not ensure production of a biological weapon that will produce a high consequence event. First of all, if an avirulent strain of a pathogen is chosen, no significant outbreak of disease will occur.[268] Even after the right strain is selected, additional hurdles face the bioterrorist, including isolation, amplification, protection against environmental degradation, and development of an effective dissemination method.

Most HCPTs are not dermally active. Therefore, to cause incapacitation or death, these agents must enter a susceptible host either through ingestion or inhalation. Since most pathogens and toxins would not survive human digestive processes, aerosolization of agents for inhalation has been acknowledged to be the most effective method for a mass casualty biological attack.[269,270] Thus, the perpetrator needs to master the skills to optimize particle size and to decrease vulnerability from environmental stressors.[271] Then the bioterrorist must be able to select and use an appropriate delivery system. These steps require

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[267] In a forthcoming book, *Malicious Motives: Assessing Terrorist Motivations and Behavioral Patterns*, edited by John Parachini, 15 cases studies of specific international terrorist groups such as the PKK, IRA, Hezbollah, Tamil Elam, and Al Qaeda are examined. In the public media, there are frequent allegations of the interest in or use of BW by these groups. The book, however, finds that in virtually every case, with the exception of Al Qaeda, there is no evidence that any of these groups produced any biological agents. Evidence regarding Al Qaeda seems to indicate only interest and the purchase of some laboratory equipment and supplies. In addition, detailed case studies of other terrorist groups such as RISE, the Red Army Faction, Minnesota Patriots Council, and the Weather Underground reveal a lack of technical skill and organization necessary for the development of mass casualty biological weapons. See also Jonathan B. Tucker (Ed.), *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*. Cambridge: MIT Press, 2000. David Johnston and James Risen, "U.S. Concludes Al Qaeda Lacked a Chemical or Biological Stockpile," *The New York Times*, March 20, 2002. Michael R. Gordon, "U.S. Says It Found Qaeda Lab Being Built to Produce Anthrax." *The New York Times*, March 23, 2002.

[268] The elderly, children, and immune-compromised individuals may still be susceptible to disease because of their weak immune systems.

[269] Even for botulinum toxin, the toxin would need to be concentrated in order for a small quantity to be effective in a food or beverage attack. Further, highly concentrated botulinum toxin is unstable unless correctly formulated.

[270] Raymond A. Zilinskas and W. Seth Carus, *Possible Terrorist Use of Modern Biotechnology Techniques* Chemical and Biological Defense Information Analysis Center, US Department of Defense, April 2002.

[271] In the fall 2001 *Bacillus anthracis* attacks, the quality of *Bacillus anthracis* used varied. The *Bacillus anthracis* samples sent to US Senators Daschle and Leahy were determined to be of a high concentration and purity, milled to yield a small particle size, and specially treated to eliminate static charge and promote aerosolization. However, many of these modifications to the *Bacillus anthracis* strain could have resulted, in whole or part, from past national biodefense activities. Therefore, at the present time, it is impossible to determine whether the perpetrator(s) had the technical skill to produce such high quality *Bacillus anthracis* or merely stole the material.

moderate to high levels of scientific expertise and pose distinct obstacles to both states and terrorists.[272,273] However, the technical hurdles for weaponizing biological agents are constant while the state and substate actors are becoming more capable with time.[274]

Finally, although a discussion of the technical hurdles is important, we must recognize that a bioterrorist need not face all of these challenges; if the bioterrorist obtains an HCPT from a research facility, he or she would not need to invest as many resources—including people—to produce an effective biological weapon agent. While this advantage is by no means insignificant, the bioterrorist would still need to—depending on the agent acquired—process and/or deploy the biological weapons material.

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[272] Elisa Harris, "Russia, Iraq and Other Potential Sources of Anthrax, Smallpox and Other Terrorist Weapons." Testimony before the Committee on International Relations, US House of Representatives. 107th Congress, December 5, 2001.

[273] US General Accounting Office, Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks, September 1999.

[274] Richard Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer. *America's Achilles Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack*, Cambridge, MA: MIT Press, 1998.

4. Conclusion

The fall 2001 anthrax attacks raised awareness of bioterrorism and intensified the debate over the nature of the threat. By combining a comparative historical analysis with an examination of the technical hurdles associated with successful biological weapons development and deployment, this study presents a holistic threat assessment that can be used to develop a comprehensive strategy to counter the biological weapons threat.

Historically, states have been responsible for the majority of biological weapons proliferation, but for a variety of reasons have rarely used the weapons they produced. First, biological weapons tend to be imprecise and ineffective in war, and states their feared use would engender overwhelming reprisal. In addition, the post-WWII era of nonproliferation spawned an increasing attitude of disapproval towards the use of biological weapons, as evidenced by the BWC. As biological weapons were seen as increasingly unattractive, many states chose to relinquish their programs. While many states possessed the resources and expertise to overcome the technical hurdles to produce biological weapons, these weapons remained of limited utility.

In the past, substate actors, lacking state resources, have had little capacity to develop high consequence biological weapons. Nonetheless, substate actors have on numerous occasions used biological weapons to produce low consequence events. In contrast to states, their use of biological weapons have not been confined to war; therefore issues such as protecting civilian populations and adhering to international norms of behavior were not disincentives to use. Nor was fear of attribution necessarily a consideration. However, substate actors' efforts at bioterrorism have been ineffective and have generally resulted in low consequence events, primarily because of the difficulty in overcoming technical hurdles.

To produce an accurate threat assessment, one must consider the current state of world affairs as well as the dominant trends that will shape the future. The major trend affecting the biological weapons threat is a marked rise in terrorist activity. Many recent terrorist incidents have been carried out by highly organized and well-funded organizations, a troubling development as—unlike terrorists of the past—these groups exhibit an increased desire for mass casualties. Some of these organizations are well positioned to take advantage of several features of the BW "landscape": the wide availability of dangerous pathogens and toxins, the growing availability of BW-related equipment, and the possibility of procuring biological weapons materials and expertise from the FSU and other nations. In addition, bioterrorists can take advantage of the numerous technological changes that have reduced the technical and financial hurdles to biological weapons development. The growing biotechnology industry provides an increasingly large base of knowledge and expertise. Moreover, antibiotic or vaccine resistant strains may increase the likelihood of a high consequence event.

Even though the technical and financial hurdles to acquiring a biological weapon are lowering over time, a high consequence biological weapon event resulting in mass casualties implies the utilization of a highly skilled, organized, and financed network of individuals. Such resources would be necessary in order to weaponize and deploy the appropriate agents. To succeed in producing a mass casualty event, agents—such as smallpox, anthrax, or plague—must be selected and/or engineered to exhibit some combination of high lethality, transmissibility, and infectivity, and would most likely need to be deployed in aerosolized form. Because of the considerable number of technical hurdles and financial resources required for producing a high consequence, mass casualty event, this outcome remains unlikely. Similar

challenges would be associated with high consequence events that do not produce mass casualties, but that may cause extreme physical damage, economic impact, or social disintegration.

A low consequence biological weapons event is one that does not result in mass casualties or other forms of damage. Producing a low consequence event requires less skill, organization, and funding than that required for a high consequence event. A variety of attack methods may be used, and a wide range of agents could be employed to cause a lower consequence bioweapons event. Generally, even low consequence events require a considerable level of expertise. In addition, the objectives of the perpetrators may be more easily realized by other means, such as conventional explosives.

However, certain types of low consequence events may be more probable. They include events committed by lone actors, both terrorist acts and biocrimes. These differ considerably from other types of low consequence events because they require little organization, funding, and expertise. Because these acts are carried out by one or a few individuals, they are less likely to be detected or prevented. Of the two categories (terrorist acts and biocrimes), biocrimes are the most likely to occur. Biocrimes are generally targeted attacks, such as assassinations or murders. Although, in this study, biocrimes are omitted from the discussion of substate actors—because they do not constitute terrorist acts—they are nonetheless worthy of note. These attacks require a very low level of organization and expertise, and have, to date, involved a limited class of agents, such as botulinum toxin and ricin. However, they may also include non-lethal agents. Because biocrime attacks can easily be carried out by a lone actor with a moderate level of technical expertise, they are more likely to occur. However the consequences will be minimal, resulting in a single death or temporary illness; generally, biocrimes cannot inflict mass casualties or the other forms of damage that designate an event as high consequence.

In conclusion, this study produces the following biological weapons threat assessment. The near-term threat from terrorists comes in the form of the deployment of existing agents while state actors could access the resources necessary to develop and deploy existing or genetically engineered agents. Although many states have the capacity to produce a high consequence event, it is unlikely. Rogue states are the most likely biological weapons perpetrators, and most can probably be deterred by retaliation with other weapons of mass destruction or overwhelming conventional force. The vast majority of substate actors are likely to continue providing a greater threat of conducting a low consequence biological weapons event. The main threat comes from highly organized, well financed terrorist groups, particularly those that desire mass casualties. The probability of such groups producing a high consequence bioterrorist event is currently low but increasing.

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