

Historical Perspectives of Microbial Bioterrorism

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1. INTRODUCTION

A number of events over the last decade have served to focus attention on the threat of terrorism and the use of biological or chemical weapons against military and civilian populations for the purpose of causing illness or death. It is increasingly recognized that agricultural animals and plants also present a vulnerable target to terrorists.^(1,2) Most significantly, the threat of terrorism has attracted the attention of policy makers in all levels of government in the United States. However, policy makers and analysts have differed in their assessment of the threat of bioterrorism. Many authorities believed that the threat of bioterrorism was growing, particularly from non-state sponsored groups.⁽³⁾ Some of them contended that it was only a matter of time before a terrorist used biologic agents to cause mass casualties, while others argued that the historical record provided no basis for concern. Moreover, some even questioned the wisdom of funding preparedness efforts.⁽⁴⁾ However, the situation changed in October 2001 when an individual or individuals sent spores of *Bacillus anthracis* to media companies in New York City and Boca Raton, Florida⁽²⁾ resulting in five deaths and considerable panic throughout the country.

1.1. Definitions

For the purposes of this article, the working definition of a biological agent is “a microorganism (or a toxin derived from it) which causes disease in man, plants, or animals or causes deterioration of material.”⁽⁶⁾ In this context, the biological agents are normally divided into three categories: anti-personnel,

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anti-animal, and anti-plant. In addition, the use of biological agents is often classified by the manner in which they are used. For example: *biological warfare* has been defined as a specialized type of warfare conducted by a government against a target; *bioterrorism* has been defined as the threat or use of biological agents (or toxins) by individuals or groups motivated by political, religious, ecological, or other ideological objectives.⁽⁷⁾ Terrorists can be distinguished from other types of criminals by their motivation and objective; criminals may also be driven by psychological pathologies and may use biological agents. When criminals use biological agents for murder, extortion, or revenge it is called a *biocrime*.⁽⁷⁾

1.2. Development and Prohibition of Biological Weapons

In November 1918, an armistice ended World War I in which eight million soldiers and nearly as many civilians were killed. However, that armistice could not halt the even greater ravages of an influenza pandemic. In the course of a single year beginning in the spring of 1918, the virus spread globally killing more than 20 million people. No one thought that this influenza pandemic was a deliberate act of war; however, the magnitude of the impact of this epidemic apparently impressed the statesmen of the era.⁽⁸⁾ When the Geneva Protocol was issued in 1925 to ban, in warfare, the use of asphyxiating, poisonous, or other gases, which had been responsible for about one million casualties during World War I,⁽⁶⁾ the provision was extended to include bacteriological agents as well.⁽⁹⁾ The Geneva Protocol affirmed that chemical and biological weapons were “justly condemned by the general opinion of the civilized world.”⁽⁸⁾

In 1972, the convention on the prohibition of the development, production, and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (referred to as the Biological Weapons Convention or BWC) was opened for signature. Since it entered into force in 1975, the BWC has been signed and ratified by 141 countries, signed but not ratified by 18 countries, and observed by the Government of Taiwan. The BWC prohibits the development, production, stockpiling, or acquisition of microbial or other biological agents or toxins of types and in quantities that have no justification for prophylactic, protective, or other peaceful purposes.⁽⁹⁾ The BWC also prohibits the weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.⁽⁹⁾ In addition, it requires that each State Party (i.e., those countries that both signed and ratified the BWC) destroy, or divert to peaceful purposes, all agents, toxins, weapons, equipment, and means of delivery which are in its possession or under its jurisdiction or control. Each State Party also agreed not to transfer any of the agents, toxins, weapons, equipment, or means of delivery to any recipient, or induce any State to manufacture or otherwise acquire such organisms or equipment for non-peaceful purposes.⁽⁹⁾ Unfortunately, the BWC has no verification provisions,

and there have been significant difficulties in determining the existence or status of State programs.

The use of biological agents for the purpose of warfare has been associated with State programs for the development of biological weapons. Some of these programs were very large, employing thousands of people. Leitenberg⁽¹⁰⁾ has recently reviewed the activities of several of these programs. Although there are inherent differences between terrorist and criminal use of biological agents, the criminal faces many of the same obstacles as the terrorist. Both must acquire, develop, and employ biological weapons, so the technical constraints will probably be similar.

The purpose of this chapter will be to provide a historical account of the use of biological agents for warfare, terrorism, or criminal purposes. However, in doing so one must appreciate that there are problems in assessing the historical use of biological agents because of: (1) difficulties in verifying an alleged or attempted biological attack; (2) the use of allegations of biological attacks for propaganda purposes; (3) a lack of pertinent microbiological or epidemiological data; (4) the presence of naturally occurring endemic or epidemic diseases during hostilities; and (5) the secrecy surrounding biological weapons programs.⁽¹¹⁾ This review relies heavily on the extensive research of Carus,⁽⁷⁾ who identified most of the events and attempts to use biological agents since 1900. This review will not cover hoaxes or attempts to acquire biological agents for nebulous purposes (e.g., Larry Wayne Harris incident⁽⁷⁾).

2. EARLY USE OF BIOLOGICAL AGENTS IN WARFARE

An examination of the way in which biological agents were used for warfare in the fourteenth through the middle of the nineteenth centuries demonstrates a correlation with the prevailing theories of infectious diseases.

2.1. Early Theories of Infectious Disease

A number of theories have evolved over time to explain the origin of epidemics. Two of these have been referred to as *miasma* and *contagion*. In the theory of miasma, epidemics were thought to be due to an atmospheric poison generated in external nature.⁽¹²⁾ Disease was thought to be a consequence of “bad air” resulting from extensive decomposition. An example of how this theory might have played a role occurred at the siege of Thun l’ eveque (Table I) where catapults were used to hurl dead horses over the wall into the castle. Years later and based on eyewitness testimony, the chronicler Froissart wrote that the “stynke and ayre was so abomydable, that they considered howe that finally they coude nat long endure” (as cited in ref 13). Miasma originated from the first-hand observations of Hippocrates (460–360 B.C.) of the effects of climate, season, and locality on outbreaks of disease.⁽¹²⁾ However, it was Galen

(130–200 A.D.) who developed the idea of “miasmatic corruption of the air”, which figured prominently in the way medicine viewed epidemics in the Middle Ages. Galen thought that epidemic disease resulted from “the inhalation of air fouled by putrid exhalations that might come from sources far and near, such as masses of unburied corpses of the slain in battle, or from swamps and stagnant water in summertime, or from the excessive heat of foul air in close and in unventilated hovels”.⁽¹²⁾ By the fourteenth century, the idea that the immediate cause of epidemics was some sort of corruption in the air was widely accepted. It was believed that this corrupted air could gain entrance to the body by way of the lungs or through wide-open pores in the skin as a result of excesses, bathing, or heat.

Also in the fourteenth century, additional prominence was given to the idea of contagion. In the theory of contagion, the “poison” was originally generated in man himself and spread person-to-person by contact with the sick or dead, or with their personal effects (fomites). The fact that some diseases were infectious and could be transmitted person-to-person had been long recognized. There are numerous biblical references in the Books of Leviticus, Numbers, and Deuteronomy to the “infectivity” of lepers. Thucydides thought that the “plague” of Athens in 430 B.C. was exceedingly infectious.⁽¹²⁾ In the fourteenth century, smallpox and measles were added to the list of infectious diseases.⁽¹²⁾

In the sixteenth century, Girolamo Fracastoro (1478–1553) recognized and defined three kinds of contagion. In his treatise *De contagione et contagionis morbis et eorum curatione*, Fracastoro attributed certain diseases including plague, smallpox, and measles, to specific tiny seeds (*seminaria*) and stated that these specific contagions could be spread directly from person-to-person, indirectly via infected clothing, wooden objects, or other fomites, and even at a distance, such as through the air.⁽¹⁴⁾

At various times, both theories were combined. Some adherents to the theory of contagion argued that the sick could radiate infection through the air in their immediate vicinity (a local miasma), while some adherents to the theory of miasma admitted a limited degree of contagion at the peak of a severe epidemic.

2.2. Selected Incidents from the Fourteenth to the Nineteenth Centuries

Table I lists a number of substantiated and unsubstantiated incidents occurring between 1340 and 1863 in which biological agents were used for the purpose of warfare. If we assume that there was intent to spread disease in order to weaken or defeat the enemy, it is possible to correlate the methods used to deliver the disease with the prevailing theories of miasma and contagion.

The claim that biological warfare was used at the 1346 siege of Caffa by the Mongols deserves special mention because of its association with the spread of the Black Death, which devastated Europe, the Near East, and North Africa

TABLE I
Selected Substantiated and Unsubstantiated Incidents of Biological Warfare, 1340–1863

| Period | Incident | Reference |
|-----------|---|-----------|
| 1340 | Jean, Duke of Normandy besieged the castle of Thun l’eveque, which had been captured by the Englishman, Sir Walter of Manny. Catapults were used to cast dead horses over the wall into the castle. Chronicled years later by Jean Froissart, based on eyewitness testimony of participants from both sides. | 13 |
| 1346 | Plague hits Mongol forces besieging the Genoese city of Caffa (now Feodosija, Ukraine) on the Crimean coast. Fresh corpses of plague victims were lobbed into the city. Plague breaks out in the city; 85,000 plague deaths in the region. Mongols abandon siege. Event chronicled in 1348–1349 by the Italian, Gabriele de’ Mussi. | 13,15 |
| 1422 | At the siege of Karlstein, machines were used to catapult corpses of those who died in battle, and manure or garbage, into the city. The incident was described 250 years after the event and is not considered credible. | 13 |
| 1500 | Pizarro presented the indigenous peoples of South America with variola-contaminated clothing. | 16 |
| 1710 | Siege of Reval (now Tallin, Estonia), Sweden. Russians were said to have hurled corpses of plague victims into the besieged city, following which plague broke out in the city. There is no documentation to support this claim. The event is referred to in a Swedish military document. | 13 |
| 1763 | During the French and Indian War (1754–1767), Sir Jeffrey Amherst, commander of British forces in North America, suggested the deliberate use of smallpox to “reduce” native American tribes hostile to the British. Captain Ecuyer (one of Amherst’s subordinates), fearing an attack on Ft. Pitt from native Americans, acquired two variola-contaminated blankets and a handkerchief from a smallpox hospital and in a false gesture of good will distributed them to the native Americans. Several outbreaks of smallpox occurred in various tribes in the Ohio River valley. | 13 |
| 1775 | In Boston, British attempted to spread smallpox among the continental forces by inoculating (variolation) civilians fleeing the city. In the south, there is evidence that the British were going to distribute slaves who had escaped during hostilities, and were sick with smallpox, back to the rebel plantations in order to spread the disease. | 13,14 |
| 1861–1863 | General W.T. Sherman complained that retreating confederate troops were deliberately shooting farm animals in ponds so that their “stinking carcasses” would contaminate water supplies for the Union forces, resulting in troops weakened and demoralized by gastrointestinal disease. Allegations that Dr. Luke Blackburn, a future governor of Kentucky, attempted to infect clothing with variola and then sell it to unsuspecting Union troops could not be substantiated. | 6 |

in the mid-fourteenth century. Wheelis⁽¹³⁾ believes that the hurling of plague-infected cadavers into the besieged city of Caffa was not only plausible, technically feasible, and consistent with contemporary notions of disease causation, but that it provided the best explanation of the entry of plague into the city. The attack itself appeared to be successful as it produced casualties within the city; however, it was of no strategic importance as the city remained in Italian hands and the Mongols abandoned the siege. These facts notwithstanding, Wheelis⁽¹⁵⁾ provides a convincing argument that this incident did not have a decisive role in the spread of plague to Europe.

3. THE GERM THEORY AND BIOTERRORISM

The seminal work of Robert Koch (1843–1910) provided the basis for the development of a new generation of biological weapons. Although others provided indirect evidence for the importance of microorganisms in causing human diseases, it was Koch who clearly conceptualized and provided experimental support for the germ theory of disease. In his early work on anthrax, he used microscopy to demonstrate that the blood of diseased animals contained large numbers of a spore-forming bacterium. He also showed that the bacteria could be cultured outside the animal body in nutrient fluids. However, to link a specific microorganism to a specific disease, the organism must first be isolated in pure culture. Toward this end, Koch developed several ingenious methods, e.g., use of nutrient medium solidified with gelatin or agar, to isolate microorganisms in pure culture. Once microorganisms were available in pure culture he was able to formulate the criteria, now called Koch's postulates, for proving that a specific type of microorganism causes a specific disease. The effects of these discoveries can be seen in the types of incidents that occurred since 1900.

3.1. Selected Confirmed Incidents, 1900–2003

Since 1900, there have been a number of incidents in which the use of a biological agent was suspected. Carus⁽⁷⁾ used specific criteria to confirm that a biological agent was used in a criminal, terrorist, or state-sponsored event. Most of the incidents in which the use of a biological agent has been confirmed are listed in Table II. Of these 29 confirmed incidents, the majority ($N = 19$) was of the criminal type. Of the remainder, five were state-sponsored and four were considered to be terrorist events. The anthrax attack of 2001, which is currently under investigation, is listed as unknown.

Among these 29 confirmed incidents, 15 involved the use of bacteria, 10 toxins, 5 viruses, and 1 used the ova of a parasitic roundworm. In three of the confirmed incidents, biological agents or toxins were used against livestock or other animals; the remainder involved the use of biological agents or toxins

TABLE II
Selected Confirmed Incidents Where Biological Agents Were Used, 1900–2003

| Date | Incident(s) | Type | Reference |
|-----------|---|----------|-----------|
| 1910 | Patrick O'Brien de Lacy and Vladimir Pantchenko (a physician) were convicted in St. Petersburg, Russia, of murdering Captain Vassilli Buturlin (de Lacy's brother in law) by injection with diphtheria toxin | Criminal | 17 |
| 1909–1918 | Henri Girard used <i>S. typhi</i> and poisonous mushrooms to murder people to whom he sold insurance policies in order to obtain the death benefits. He was responsible for killing two people; six others recovered after being infected or poisoned. Girard was studying bacteriology at the time of the first murder | Criminal | 7,17 |
| 1913 | Karl Hopf infected his third wife with <i>V. cholerae</i> and typhus organisms. He murdered his father, two of his children and his first wife with arsenic. He was also accused of attempting to poison his second and third wives and his mother. Hopf had training in handling drugs. He was convicted in a German court | Criminal | 7 |
| 1915–1918 | The German Secret Service instituted a covert biological warfare campaign in the United States during the early part of World War I, while the United States was still neutral. They used <i>B. mallei</i> (glanders) and <i>B. anthracis</i> (anthrax) to infect horses and mules that Allies purchased in the United States for use by their forces in Europe. In Romania, they infected sheep bound for Russia with glanders and anthrax. In Argentina, they infected sheep, cattle, and horses with glanders and anthrax that were being shipped to Britain and to the Indian army. They purportedly used <i>B. mallei</i> and <i>V. cholerae</i> against allied forces during the German retreat | State | 18 |
| 1916 | Arthur Warren Waite was a dentist who had made serious attempts to acquire virulent pathogens. He killed his mother-in-law by putting pathogenic microorganisms in her food. When an attempt to kill his father-in-law using pathogens was unsuccessful, he poisoned him with arsenic | Criminal | 7 |
| 1932 | The League of Nation's General Assembly established the Lytton Commission in December, 1931, to investigate Japan's conquest of Manchuria. When commissioners visited Manchuria in 1932, the Japanese served them fruit "laced" with <i>V. cholerae</i> . No one became ill | State | 7 |
| 1933 | Dr. Taranath Bhattacharyna was a physician with training in bacteriology. He and Benoyendra Chandra Pandey murdered 20-year-old Amarendra Pandey (half brother of Benoyendra) with a lethal dose of <i>Y. pestis</i> after a feud over the division of their father's estate | Criminal | 7,19 |

(continued)

TABLE II
(Continued)

| Date | Incident(s) | Type | Reference |
|-----------|--|-----------|-----------|
| 1936 | Dr. Tei-Sabro Takahashi was a Japanese physician who used food contaminated with <i>S. typhi</i> to infect 17 people, including three who subsequently died. The incidents involved competing physicians, their families, and his wife | Criminal | 7 |
| 1939 | Dr. Kikuko Hirose, a Japanese physician, gave pastries contaminated with <i>S. typhi</i> and <i>S. paratyphi</i> to her former husband who, in turn, shared them with others. Twelve became ill and one died | Criminal | 7 |
| 1932–1945 | Japan conducted biological weapons research at facilities in China (e.g., Unit 731). Prisoners were infected with pathogens including <i>B. anthracis</i> , <i>N. meningitidis</i> , <i>V. cholerae</i> , <i>Y. pestis</i> , and <i>Shigella</i> spp. Between 1932 and 1945, more than 10,000 prisoners died as a result of experimental infection or execution following experimentation. At least 11 Chinese cities were attacked with biological weapons sprayed from aircrafts or introduced into water supplies or food items. Plague-infected fleas were released from aircraft over Chinese cities to initiate plague epidemics | State | 20 |
| 1952 | The Mau Mau used the plant toxin from the African milk bush (<i>Synadenium grantii</i>) to kill livestock in what is now Kenya. | Terrorist | 7 |
| 1964 | Dr. Mitsuru Suzuki, a Japanese physician with training in bacteriology, was arrested for infecting four colleagues with a sponge cake contaminated with dysentery. He was subsequently linked to a series of typhoid fever and dysentery outbreaks involving approximately 200 people, including four deaths. Prosecutors claimed he did this to complete his dissertation, which involved studies of <i>S. typhi</i> recovered from numerous persons. A culture of <i>S. typhi</i> was stolen from Japan’s NIH; another culture was isolated from an infected patient | Criminal | 7 |
| 1970 | Eric Kranz, a postgraduate student in parasitology at MacDonald College, infected four of his room-mates using food contaminated with large numbers of embryonated ova of <i>Ascaris suum</i> , a parasitic roundworm found in pigs. The infected individuals presented with symptoms and signs of lower respiratory tract disease, the more severely ill being in acute respiratory failure | Criminal | 21 |
| 1977 | Arnfinn Nasset, who ran a nursing home for the elderly in Norway, was convicted of murdering 22 of his patients by injecting them with curacit, which is derived from curare | Criminal | 7 |

TABLE II
(Continued)

| Date | Incident(s) | Type | Reference |
|-----------|---|-----------|-----------|
| 1978 | The Bulgarian secret police attempted to assassinate Vladimir Kostov, a Bulgarian defector who had served as a news correspondent and was also a major in the D.S. (Bulgarian equivalent to the K.G.B.). A small metal pellet containing ricin was injected into Kostov who subsequently became ill but did not die | State | 7,22 |
| 1978 | In London, the Bulgarian secret police assassinated Georgi Markov, a Bulgarian dissident and announcer for Radio Free Europe. He was killed by ricin contained in a small platinum-iridium pellet that was injected into the back of his thigh by means of a modified umbrella tip. He died 4 days later | State | 7 |
| 1981 | A group calling itself “Dark Harvest” was responsible for leaving a package of soil on the grounds of the Chemical Defense Establishment located at Porton Down, England. By doing so, they claimed they were returning “seeds of death” to their source. The group claimed the soil was a part of a larger quantity (300 pounds) removed from Gruinard Island where tests of anthrax bombs were conducted in 1941. They also stated that microbiologists from two universities and locals were involved in removing the soil. Analysis showed that the soil contained <i>B. anthracis</i> (approx. 10 organisms/gram of soil) | Terrorist | 7 |
| 1984 | The Rajneeshees, a religious cult, employed biological agents against inhabitants of The Dalles, Oregon in an attempt to influence the local government. In the first incident, two county commissioners visiting the commune were given drinking water contaminated with <i>S. Typhimurium</i> —both became sick. Later, members of the cult contaminated salad bars, salad dressing, and coffee creamers in local restaurants with <i>S. Typhimurium</i> . As a result, 751 people became sick. Attempts were also made to contaminate the water system. Bactrol discs containing <i>S. Typhimurium</i> were legitimately obtained from VWR Scientific in Seattle for use in their medical clinic’s state-licensed laboratory. It was later removed to a clandestine laboratory where large quantities were grown | Terrorist | 7,23 |
| 1990–1995 | The Aum Shinrikyo is a religious cult that was responsible for the 1995 dissemination of sarin gas in the Tokyo subway system. The cult claimed they had 10,000 members and assets of ≥\$300 million dollars. The cult was also involved in biological warfare activity involving botulinum neurotoxin, <i>B. anthracis</i> , <i>C. burnetii</i> , and attempted to obtain Ebola virus from Zaire. The group attempted to use aerosolized biological agents against nine targets including: | | |

(continued)

TABLE II
(Continued)

| Date | Incident(s) | Type | Reference |
|------|---|-----------|-----------|
| | botulinum toxin (Japan Parliament, Narita International airport, downtown Tokyo, and Tokyo subway); and anthrax (sprayer on the roof of the Aum building in East Tokyo, a truck sprayer around the Diet in Central Tokyo, Imperial palace, Yokohama, and the U.S. Naval base at Yokosuka). None of these attacks were successful due to the selection of the wrong strain or to the conscience of the individual responsible for filling the dissemination devices | Terrorist | 7,24,25 |
| 1990 | Graham Farlow was an asymptomatic HIV-positive inmate at a prison in New South Wales, Australia. He injected a guard (Geoffrey Pearce) with HIV-contaminated blood. The guard became infected with HIV. Farlow died of AIDS | Criminal | 26 |
| 1992 | Brian T. Stewart worked as a phlebotomist at a St. Louis, MO hospital. He injected his 11-month-old son with HIV-contaminated blood during a fight over payment of child support | Criminal | 7 |
| 1993 | Iwan E was a Dutch man who injected his former girlfriend (Gina O) with 2.5 ml of HIV-contaminated blood after she broke up with him | Criminal | 7,27 |
| 1994 | Dr. Richard J. Schmidt, a married Louisiana gastroenterologist, injected a former lover with HIV-contaminated blood. Laboratory tests demonstrated that she contracted the same strain of HIV as found in one of Dr. Schmidt's patients | Criminal | 7 |
| 1995 | Dr. Debora Green, an oncologist, attempted on three occasions to kill her estranged cardiologist husband (Dr. Michael Farrar) by putting ricin in his food. When these attempts failed, she set fire to her house killing two of her three children. Green was a heavy drinker and appeared to suffer from a severe psychiatric disorder | Criminal | 7,28 |
| 1996 | Diane Thompson worked in the laboratory at St. Paul Medical Center hospital in Dallas, TX. She contaminated pastries (blueberry muffins and doughnuts) with <i>S. dysenteriae</i> type 2, placed them in a break room, and sent an email to laboratory personnel that food was available in the break room. Twelve people who worked in the laboratory became sick after eating the contaminated food; another person became ill after consuming pastry brought home by one of the laboratory workers. Four of the people were sufficiently sick to require hospitalization. A year earlier, she infected her boy friend (John P. Richy) with same organism. Thompson then falsified laboratory test results so that physicians would not learn of his infection. She infected him again after his release from the hospital, and a third time by injecting him with microorganisms while purporting to take a blood specimen | Criminal | 7,29 |

TABLE II
(Continued)

| Date | Incident(s) | Type | Reference |
|------|--|----------|-----------|
| 1997 | Unknown farmers deliberately and illegally introduced rabbit hemorrhagic disease (a calicivirus) into the south island of New Zealand as an animal control tool to kill feral rabbits | Criminal | 7 |
| 2001 | Shortly after 9/11 someone mailed letters containing spores of <i>B. anthracis</i> to media companies and governmental officials resulting in 22 cases of anthrax (11 inhalational and 11 cutaneous). Five of those with inhalational anthrax died | Unknown | 5,30 |
| 2002 | Chen Zhengping spiked food in a rival's pastry shop in Tangshan, near Nanjing, with tetramine, a toxin from the red whelk. Up to 300 people fell sick and 38 people died | Criminal | 31 |
| 2003 | A letter signed "Fallen Angel" complaining about new federal trucking regulations and a threat to use ricin was enclosed in a package with a vial that contained ricin. Also, another letter addressed to the White House and signed "Fallen Angel" was intercepted at an off-site mail sorting facility. The letter contained low potency ricin | Criminal | 32 |

against humans. The largest non-state sponsored event involved 751 people who were deliberately infected by *Salmonella* Typhimurium (Table II). There were no confirmed incidents involving the use of biological agents against crops. Most of the incidents (4/5) involving viruses occurred in the 1990s, were of a criminal nature, and involved the injection of the human immunodeficiency virus (HIV). Ricin was the most common toxin used ($n = 4$) in those incidents where toxins were used in assassination (state-sponsored) or for murder (criminal). Bacteria were used in 11/24 non-state sponsored incidents. The majority of the bacterial species that were used belonged to the Enterobacteriaceae, which is reflective of the method used to deliver the bacteria.

The method used to disseminate the agent was not known in every case. However, in those cases where it was known, ingestion of contaminated food ($N = 15$), injection ($N = 10$), and inhalation ($N = 2$) were most often used.

It was also interesting to note that a significant proportion of the non-state sponsored incidents (16/22; 73%) were perpetrated by individuals with scientific or medical training.

3.2. Probable or Possible use of Biological Agents, 1900–2003

In addition to those confirmed instances in which biological agents have been used for criminal, terrorist, or military purposes, there have been a number of instances in which it is likely, though not confirmed, that a biological agent(s) was used. The incidents described in Table III have been selected from those described by Carus.⁽⁶⁾

TABLE III
Probable or Possible Use of Biological Agents, 1900–2003

| Date | Incident(s) | Reference |
|-----------|---|-----------|
| 1900 | It has been claimed that castor beans (ricin) were used in Malawi to kill unwanted offspring by inclusion of the seed in food | 7 |
| 1909 | Dr. Bennett Clark Hyde, a surgeon living in Kansas City, MO, was indicted for the alleged murder of Colonel Thomas H. Swope. He was never convicted nor acquitted of the charge. However, he likely used <i>S. typhi</i> to infect several individuals of whom one died | 7 |
| 1910 | In Mexico, supporters of Pancho Villa were thought to have used botulinum toxin against Mexican Federal troops | 7 |
| 1917 | In the United States, there were reports that German sympathizers possibly contaminated certain brands of courtplaster (an adhesive plaster used to cover small wounds) with <i>C. tetani</i> | 7 |
| 1940s | An Egyptian gangster purportedly used stolen culture of <i>S. typhi</i> as part of a plot to murder insured victims | 7 |
| 1942 | Polish Resistance purportedly used typhus against German forces. Also, the staff at the Institute of Hygiene in Warsaw reportedly contaminated letters with spores of <i>B. anthracis</i> and sent them to the Gestapo so that they would be reluctant to open other letters naming resistance fighters | 7 |
| 1947 | During the 1947 war, “Zionists” might have contaminated wells around Gaza with <i>S. dysenteriae</i> and <i>S. typhi</i> | 7 |
| 1969 | Dr. John R. Hill, a Houston plastic surgeon, purportedly killed his wife (Joan Robinson Hill) using an injection of a bacterial mixture | 33 |
| 1971 | The KGB attempted to assassinate Alexander Solzhenitsyn with ricin in Novochoerkassk, USSR | 7 |
| 1976 | The Rhodesian Central Intelligence Organization (CIO) used the services of Robert Symington (Professor of Anatomy, University of Rhodesia) who, in turn, recruited other faculty members and students into his program to develop chemical and biological agents. In 1975, researchers tested some of the agents on detainees. Members of the Selous Scouts were used to disseminate <i>V. cholerae</i> in the Ruya river and water supply of the town of Cochemane in Mozambique. Deaths that were attributed to cholera occurred in both areas. <i>B. anthracis</i> was introduced into rural areas of western Zimbabwe resulting in several hundred human deaths | 7,34 |
| 1970–1980 | Eastern Bloc agents may have attempted to assassinate Stefan Bankov on a flight between Seattle and London in 1974. In 1981, Boris Korczak, a CIA double agent, was killed with a platinum-iridium pellet containing ricin | 7 |
| 1987–1990 | Dr. David Acer, a Florida dentist infected with HIV, transmitted the disease to six of his patients. Intentional infection of these patients is a possibility although there is no direct evidence. The source of their infection remains controversial | 7,35 |

TABLE III
(Continued)

| Date | Incident(s) | Reference |
|------|--|-----------|
| 1989 | In South Africa, a covert operation group (Civilian Cooperation Bureau [CCB]) employed biological agents against the South West Africa People's Organization (SWAPO). Dr. Wouter Basson was the head of Project Coast, codename for South Africa's covert biological and chemical weapons program. Roodeplaat Research Laboratories, which was associated with the program, produced approx. 500 products including 32 bottles containing <i>V. cholerae</i> cultures, chocolate and cigarettes laced with <i>B. anthracis</i> , beer containing botulinum toxin, and sugar containing <i>Salmonella</i> spp. It was claimed that they infected three Russian advisors to the ANC and one died | 7,34 |
| 1990 | Nine cases of diarrheal disease due to <i>G. lamblia</i> occurred in residents of an apartment building in Edinburgh, Scotland. Investigators discovered that one of the tanks that supplied water to the building had been broken into and contaminated with <i>Giardia</i> -containing fecal material | 6,36 |
| 1992 | Canadian authorities in Alberta alleged that Marilyn Tan deliberately injected Con Boland with HIV-contaminated blood during a sexual encounter. There was insufficient evidence to convict Tan | 7 |

4. CONCLUDING REMARKS AND PERSPECTIVES

For centuries, biological agents have been used either for warfare, terrorist, or criminal activities. Some of the perpetrators have been governments (state-sponsored), non-governmental groups (e.g., religious cults), or individuals. Today, the threat of mass casualties from bioterrorism is real; however, from a historical perspective there have been relatively few confirmed instances in which a terrorist has used a biological agent. Most of the confirmed instances involving the use of a biological agent have been for criminal purposes. Current efforts to prepare the public health system in the United States for bioterrorism through the enhancement of surveillance, epidemiology, and laboratory capacity should lead to the early detection of the event and minimize the number of casualties.⁽³⁷⁾

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