HISTORY OF CHEMICAL WARFARE AND CURRENT THREAT

The use of biological weapons and efforts to make them more useful as a means of waging war have been recorded numerous times in history. Two of the earliest reported uses occurred in the 6th century BC, with the Assyrians poisoning enemy wells with rye ergot, and Solon's use of the purgative herb hellebore during the siege of Krissa. In 1346, plague broke out in the Tartar army during its siege of Kaffa (at present day Feodosia in Crimea). The attackers hurled the corpses of those who died over the city walls; the plague epidemic that followed forced the defenders to surrender, and some infected people who left Kaffa may have started the Black Death pandemic which spread throughout Europe. Russian troops may have used the same plague-infected corpse tactic against Sweden in 1710.

On several occasions, smallpox was used as a biological weapon. Pizarro is said to have presented South American natives with variola-contaminated clothing in the 15th century, and the English did the same when Sir Jeffery Amherst provided Indians loyal to the French with smallpox-laden blankets during the French and Indian War of 1754 to 1767. Native Americans defending Fort Carillon sustained epidemic casualties which directly contributed to the loss of the fort to the English.

In this century, there is evidence that during World War I, German agents inoculated horses and cattle with glanders in the U.S. before the animals were shipped to France. In 1937, Japan started an ambitious biological warfare program, located 40 miles south of Harbin, Manchuria, in a laboratory complex code named "Unit 731". Studies directed by Japanese General Ishii continued there until 1945, when the complex was leveled by burning it. A post World War II investigation revealed that numerous organisms had received Japanese research attention, and that experiments had been conducted on prisoners of war. Slightly less than 1,000 human autopsies apparently were carried out at Unit 731, most on victims exposed to aerosolized anthrax. Many more prisoners and Chinese nationals may have died in this facility - some have estimated up to 3,000 human deaths. In 1940, a plague epidemic in China and Manchuria followed reported overflights by Japanese planes dropping plague-infected fleas. By 1945, the Japanese program had stockpiled 400 kilograms of anthrax to be used in a specially designed fragmentation bomb.

In 1943, the United States began research into the offensive use of biological agents. This work was started, interestingly enough, in response to a perceived German biological warfare (BW) threat as opposed to a Japanese one. The United States conducted this research at Camp Detrick (now Fort Detrick), which was a small National Guard airfield prior to that time, and produced agents at other sites until 1969, when President Nixon stopped all offensive biological and toxin weapon research and production by executive order. Between May 1971 and May 1972, all stockpiles of biological agents and munitions from the now defunct U.S. program were destroyed in the presence of monitors representing the United States Department of Agriculture, the Department of Health, Education, and Welfare, and the states of Arkansas, Colorado, and Maryland. Included among the destroyed agents were *Bacillus anthracis*, botulinum toxin, *Francisella tularensis*, *Coxiella burnetii*, Venezuelan equine encephalitis virus, *Brucella suis*, and Staphylococcal enterotoxin B. The United States also had a medical defensive program, begun in 1953, that continues today at USAMRIID.

In 1972, the United States and many other countries signed the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, commonly called the Biological Weapons Convention. This treaty prohibits the stockpiling of biological agents for offensive military purposes, and also forbids research into such offensive employment of biological agents. The former Soviet Union and the government of Iraq were both signatories to this accord. However, despite this historic agreement among nations, biological warfare research continued to flourish in many countries hostile to the United States. There were also several cases of suspected or actual use of biological weapons. Among the most notorious of these were the "yellow rain" incidents in Southeast Asia, the accidental release of anthrax at Sverdlovsk, and the use of ricin as an assassination weapon in London in 1978.

Testimony from the late 1970's indicated that the countries of Laos and Kampuchea were attacked by planes and helicopters delivering aerosols of several colors. After being exposed, people and animals became disoriented and ill, and a small percentage of those stricken died. Some of these clouds were thought to be comprised of trichothecene toxins (in particular, T2 mycotoxin). These attacks are lumped under the label "Yellow Rain". There has been a great deal of controversy about whether these clouds were truly biological warfare agents: some have argued that the clouds were nothing more than bee feces produced by swarms of bees.

In late April of 1979, an incident occurred in Sverdlovsk (now Yekaterinburg) in the former Soviet Union which appeared to be an accidental release of anthrax in aerosol form from the Soviet Military Compound 19, a microbiology facility. Residents living downwind from this compound developed high fever and difficulty breathing, and a large number died. The final death toll was estimated at the time to be between 200 and 1,000. The Soviet Ministry of Health blamed the deaths on the consumption of contaminated meat, and for years controversy raged in the press over the actual cause of the outbreak. All evidence available to the United States government indicated a massive release of aerosolized anthrax. In the summer of 1992, U.S. intelligence officials were proven correct when new Russian President Boris Yeltsin acknowledged that the Sverdlovsk incident was in fact a large scale accident involving the escape of an aerosol of anthrax spores from the military research facility. In 1994, Meselson and colleagues published an in-depth analysis of the Sverdlovsk incident (*Science* 266:1202-1208). They documented that all of the 1979 cases occurred within a narrow zone extending downwind in a southerly direction from Compound 19. A total of 77 patients were identified by Meselson's team, including 66 fatalities and 11 survivors.

Before the Sverdlovsk incident, in 1978, a Bulgarian exile named Georgi Markov was attacked in London with a device disguised as an umbrella which injected a tiny pellet filled with ricin toxin into the subcutaneous tissue of his leg while he was waiting for a bus. He died several days later. On autopsy, the tiny pellet was found and determined to contain the toxin. This assassination, it was later revealed, was carried out by the communist Bulgarian government, and the technology to commit the crime was supplied to the Bulgarians by the former Soviet Union.

In August of 1991, the first United Nations inspection of Iraq's biological warfare capabilities was carried out in the aftermath of the Gulf War. On August 2, 1991, representatives of the Iraqi government announced to leaders of United Nations Special Commission Team 7 that they had conducted research into the offensive use of *Bacillus anthracis*, botulinum toxins, and *Clostridium perfringens* (presumably one of its toxins). This was the first open admission of biological weapons research by any country in recent memory, and it verified many of the concerns of the U.S. intelligence community publicly. Iraq had extensive and redundant research facilities at Salman Pak and other sites, many of which were destroyed during the war.

In 1995, further information on Iraq's offensive program was made available to United Nations inspectors. Iraq conducted research and development work on anthrax, botulinum toxins, *Clostridium perfringens*, aflatoxins, wheat cover smut, and ricin. Field trials were conducted with *Bacillus subtilis* (a simulant for anthrax), botulinum toxin, and aflatoxin. Biological agents were tested in various delivery systems, including rockets, aerial bombs, and spray tanks. In December 1990, the Iraqis filled 100 R400 bombs with botulinum toxin, 50 with anthrax, and 16 with aflatoxin. In addition, 13 Al Hussein (SCUD) warheads were filled with botulinum toxin, 10 with anthrax, and 2 with aflatoxin. These weapons were deployed in January 1991 to four locations. All in all, Iraq produced 19,000 liters of concentrated botulinum toxin (nearly 10,000 liters filled into munitions), 8,500 liters of concentrated anthrax (6,500 liters filled into munitions) and 2,200 liters of aflatoxin (1,580 liters filled into munitions).

The threat of biological warfare has increased in the last two decades, with a number of countries working on offensive use of these agents. The extensive program of the former Soviet Union is now controlled largely by Russia. Russian president Boris Yeltsin has stated that he will put an end to further offensive biological research; however, the degree to which the program has been scaled back, if any, is not known. Recent revelations from a senior BW program manager who defected from the FSU in 1992 outlined a remarkably robust biological warfare program including active research into genetic engineering, binary biologicals and chimeras. There is also growing concern that the smallpox virus, eliminated from the face of the earth in the late 1970's and now stored in only two laboratories at the CDC in Atlanta and the Institute for Viral Precautions in Moscow, Russia, may have been "bargained" away by desperate Russian scientists seeking money.

There is intense concern in the West about the possibility of proliferation or enhancement of offensive programs in countries hostile to the western democracies, due to the potential hiring of expatriate Russian scientists. It was reported in January 1998 that Iraq had sent about a dozen scientists involved in BW research to Libya to help that country develop a biological warfare complex disguised as a medical facility in the Tripoli area. In a report issued in November 1997, Secretary of Defense William Cohen singled out Libya, Iraq, Iran, and Syria as countries "aggressively seeking" nuclear, biological, and chemical weapons.

There is also an increasing amount of concern over the possibility of terrorist use of biological agents to threaten either military or civilian populations. There have been cases of persons loyal to extremist groups trying to obtain microorganisms which could be used as biological weapons. The Department of Defense is leading a federal effort to train the first responders in 120 American cities to be prepared to act in case of a domestic terrorist incident involving WMD.

Certainly the threat of biological weapons being used against U.S. military forces is broader and more likely in various geographic scenarios than at any point in our history. Therefore, awareness of this potential threat and education of our leaders and medical care providers on how to combat it are crucial.