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An Introduction to Biological Weapons, their Prohibition, and the Relationship to Biosafety

Introduction

This paper is an introduction to biological weapons and biological weapons control for persons familiar with biosafety and biodiversity issues. It provides biological weapons history and discusses the future of biological weapons and their prohibition. It highlights relationships between the Biological and Toxin Weapons Convention and the Cartagena Biosafety Protocol, including areas where an integrative approach in addressing biosafety and biosecurity policy and implementation issues can achieve the connected goals of ensuring biosafety and preventing development of biological weapons.

Biological warfare agents are a unique class of weapons that pose dangers to all biodiversity and whose future threat is directly linked to the regulation of modern biotechnology. Biological weapons include living organisms that are able to reproduce and perpetuate their destructive mission beyond the intended target area and time. Biosafety and biosecurity both relate to new genetic techniques and to the release of living organisms into the environment with harmful impacts.

Thirty years ago, on April 10 1972, the Biological and Toxin Weapons Convention (BTWC) was opened for signature. The BTWC outlaws any development and production of biological weapons and has contributed to biological disarmament and the prevention of a biological arms race. The last decade, however, has witnessed dramatic and rapid changes in bioscience that are easing the development of biological weapons.

Considering the worldwide availability of modern biotechnology know how and hardware, it is obvious that classical biowarfare agents like anthrax are now much easier to produce than 30 years ago. And new genetically engineered weapons for non-traditional conflicts are already under development, threatening to undermine the global consensus against the hostile use of living organisms and thereby endangering every country and its resources.

Use of modern biotechnology entails biodiversity, health and security risks. By using genetic engineering and closely-related techniques, an expanding variety of new organisms can and have been created that pose risks to biodiversity and human health. The dangers these organisms pose is multiplied by the possibilities of their exploitation as weapons. A quintessential example in this regard is an experiment with mousepox viruses in Australia that were genetically engineered to induce sterility in mice. Unexpectedly, the experiment actually generated more lethal strains of mousepox. From a biosafety point of view, this highlights the potential dangers of genetic engineering, and from a biosecurity point of view it underlines the vast potential of genetic engineering to generate new weapons.

Because of their common focus on biotechnology risks, regulating the safety of genetically engineered organisms and preventing the development of biological weapons can – and should – be mutually supportive processes. Some provisions of the Cartagena Biosafety Protocol and of the Biological and Toxin Weapons Convention (BTWC) point in similar directions and offer possibilities for synergies. The agreements share elements in their purpose, subject matter, precaution, technology transfer, emphasis on human well-being, and concern with identification and movement of biological agents. Preliminary recommendations are made on how these instruments can work together.

What is Biological Warfare?

Biological warfare is the use of living organisms or their byproducts (toxins) to inflict harm. Biological weapons can have devastating effects on all kinds of biodiversity, including humans, animals, plants, and other life. They can also be used against resources, for example water or food supplies and, in modern applications, against natural and manufactured materials.

There are a number of misperceptions about biological weapons and warfare. A common one is that the definition of biological warfare relates to a weapon's target. This is untrue. Explosives, radiation, chemicals, or other non-biological weapons can be extremely damaging to biodiversity; but are not biological weapons. Biological warfare is about the agents, and the term is only properly applied to the use of living organisms (or toxins they produce) as weapons.

Another misperception is that the term "biological weapon" is only used for diseases that attack humans. This is also untrue. Many effective biological weapons attack animals (e.g. avian influenza viruses) and crops (e.g. rice blast - ***Piricularia oryzae***). Importantly, biological weapons attacks on crops, animals, and other resources also have impacts on humans and ecology, making their potential for disruption even greater than that of the diseases themselves.

A third misperception is that biological warfare refers only to agents that kill. While very lethal agents are of very great concern, many biological agents that do not generally kill can also be used in warfare. Foot and mouth disease (***Aphthovirus spp.)*** is an excellent example. There is a parallel between this type of biological agent and other weapons, such as some anti-personnel land mines, which are intended to cause injury (not death). Diseases like Q fever (***Coxiella burnetti***), dengue (***Flavivirus*** spp.), and brucellosis (***Brucella*** spp.), have a low fatality rate compared with agents like anthrax; but can still be used to severely weaken an enemy, particularly a civilian population. An attack on Cuba with so-called "incapacitating" biological weapons was discussed by US Defense Department officials during the Cuban Missile Crisis in 1962. In agriculture, a similar approach might be taken with attacks with pathogens that reduce (or spoil) harvests without necessarily killing the cultivated plants.

Although biological warfare includes all organisms used as weapons, many of the biological weapons that are most talked about are microorganisms. Well known are a number of so-called "classical" biological warfare agents, including bacteria such as anthrax and viruses like smallpox. Other types of microorganisms that can be used as biological weapons include fungi, rickettsia and toxin-producing microbes (for example, algae that produce saxitoxin, one of the most deadly non-protein substances known).

Insect pests can also be used as biological weapons, for example thrips (***Thrips palmi***) to devastate crops. The United States is currently investigating the use of insect enemies of coca, opium poppy, and cannabis as biological weapons in the Drug War. Insect species can also be used as vectors for the distribution of disease. In the 1950s, US studies such as Operations "Big Itch" and "Big Buzz" demonstrated the feasibility of mass producing and distributing disease-infected mosquitoes from aircraft. A partially declassified 1981 US Army report details this approach, including use of mosquitoes as a vector for yellow fever, even calculating a "cost per death" figure.[1] More recent US efforts in the Drug War come into play here too, as a US agriculture team based at Fort Detrick, Maryland, is attempting to find vectors for a virus that devastates opium poppy.

Some intrinsic features of biological agents that make them suitable for hostile use are infectivity; virulence; toxicity; pathogenicity; incubation period; transmissibility; lethality; and stability. Unique to many of biological weapons agents, and distinctive from other agents such as chemical weapons, is their ability to reproduce, multiplying over time and thereby increasing their effect.

Biowarfare in History

Biological weapons are as old as humanity itself and have been used with regularity throughout history. Before recorded time, Neanderthals dirtied stone points (arrows) with faeces in order to deliberately spread disease and enhance their weapons' effects. During the Roman Empire, animal cadavers were thrown into wells in order to poison water sources. In 1346, after a three year siege of the city of Kaffa, Tartars are believed to have catapulted the bodies of victims of the plague (***Yersinia pestis***) into the city in order to weaken the city's resistance.

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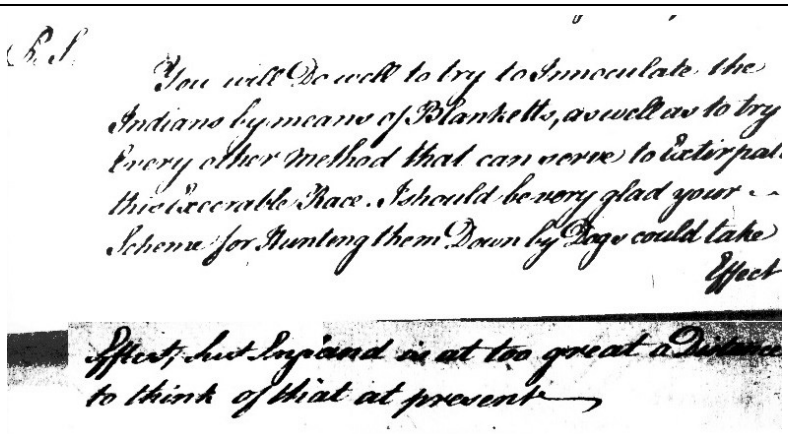
[1] Rose W. 1981. *An Evaluation of Entomological Warfare as a Potential Danger to the United States and European NATO Nations*, US Army Test and Evaluation Command, Dugway Proving Ground. Portions available online at: http://www.thesmokinggun.com/archive/mosquito1.shtml

The decimation of indigenous peoples by disease during colonial times is sometimes described as an "accidental" or "unintended" result of the spread of diseases to new areas. But at times it was biological warfare with genocidal intent. In a 17th Century attempt to "extirpate" North American indigenous people, the British Army attacked Native Americans by distributing blankets that had been infected with the smallpox virus (***Variola major***).



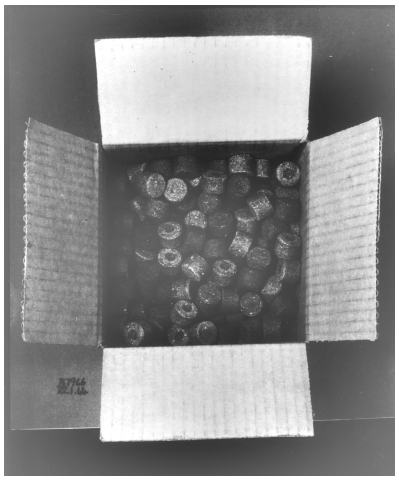
"You will do well by trying to innoculate the Indians by means of blanketts, as well as to try every other method that can serve to extirpate this execrable race. I should be very glad your scheme for hunting them down by dogs could take effect, but England is at too great a distance to think of that at present."

- Lord General Jeffrey Amherst, British Commander-in-Chief of America, to Colonel Henry Bouquet 16 July 1763. (Image courtesy of Peter d'Errico.)

In World War I, German saboteurs infected enemy horses and cattle with glanders (***Burkholderia mallei***) and anthrax (***Bacillus anthracis***) and grain with fungi. Germany had biological warriors as far away as the United States and Argentina, where operatives working as dockhands attempted to infect live animals being loaded for export to Europe.

The largest use of biological weapons that has ever occurred took place during the Second World War, when the infamous Japanese Army Unit 731 based in occupied Manchuria killed thousands of prisoners and villagers. The unit conducted cruel biological warfare experiments on prisoners of war and large scale biological weapons attacks on Chinese villages with bombs and devices laced with plague and other diseases.

Also during World War II, military researchers in the United Kingdom performed tests with anthrax bombs on the Scottish island of Gruinard. The island was so severely contaminated that it was off-limits to humans for fifty years. Concerned that Germany might also be pursuing biological weapons, the United Kingdom set a policy to have a biological retaliation prepared for use in the event of a Nazi biological attack.[2] The UK produced millions of cattle cakes (feed) contaminated with anthrax. The cakes were designed to be dropped from airplanes over Germany in order to kill German livestock and cripple the country's food supply. In 1944 in the United States, a biological bomb production plant was built that was capable of producing a half a million 4 pound anthrax bomblets every month.



Anthrax-laced cattle feed was prepared by the UK during World War II. (Photo courtesy of Eberhard Geissler.)

After World War II and through the 1960s, only a few countries maintained major offensive biowarfare programs and generated the knowledge and the technical means to produce and use biological weapons. The United States, the United Kingdom, and (later) the former Soviet Union were among those few, producing and stockpiling biological weapons agents. For example, during the 1960s, the United States stockpiled 36,000 kilograms of wheat stem rust and nearly a ton of rice blast. To distribute plant diseases, the US adapted a device used for distributing leaflets from the air, instead filling it with pathogen-coated feathers. The UK scaled back its

[2] It is worth noting that the biological arms race that started in World War II was mainly triggered by intelligence reports that Nazi Germany was engaged in a full blown offensive BW program. The reports turned out to be false. The history of biological weapons is also a history of secret service failure, a point to bear in mind when today's intelligence services make unsubstantiated allegations of offensive programs in some states.

program in the mid 1950s, and in 1969 the US officially renounced offensive research, paving the way for the Biological and Toxin Weapons Convention (BTWC) of 1972, which bans the development, production and stockpiling of all biological agents for non-peaceful purposes.

Since the 1980s, three offensive programs have been unraveled: The former Soviet Union had a huge program until 1992. After the 1991 Gulf War, a UN Special Commission found clear evidence of (and destroyed the facilities of) an offensive program in Iraq. And through the Truth and Reconciliation Commission it became clear that the former Apartheid regime in South Africa also engaged on offensive biological weapons research.

As disturbing as the historical cases are, the past of biowarfare can also be interpreted as history in which use of biological weapons has been limited. Few large scale deployments in wartime have happened. A major reason is the obvious technical difficulty and the "boomerang effect" that bioweapons can have. Handling and using contagious diseases poses a threat of infection to an aggressor's own soldiers and population. It also technically challenging to develop biowarfare agents for large scale use. Relatively sophisticated microbiology is needed to isolate and grow microbes in a reliable manner, and special means of delivery such as aerosol techniques must be available.

Beginning in the 1970s, and accelerated by the explosion of commercial biotechnology since the 1990s, genetic engineering has opened many new and deeply worrying avenues for the creation of biological weapons. Modern biotechnology is also enhancing the usability of biological weapons beyond classical state vs. state warfare towards other conflicts such as temporary intervention (including peacekeeping) and undeclared or secret conflicts including trade disputes or covert government destabilization attempts. These aspects of biotechnology are profiled later in this paper and are a major reason biosafety and biological weapons control must work closely together.

Bioweapons' Potential Harm to Humans

Delivered under optimal conditions, the pound for pound killing capacity of biological agents exceeds that of nuclear weapons. It is estimated that in a major urban area the detonation of a one megaton hydrogen bomb would result in between 570,000 and 1,900,000 deaths. One hundred kilograms of anthrax spores delivered optimally would result in between one and three million deaths. Under less optimal conditions (sunny, windy, bright light, etc...) the same amount might kill between 130,000 and 1,400,000 people. Chemical weapons, while horrific, are comparatively less powerful. The same amount of sarin nerve gas, delivered on under optimal conditions, would be unlikely to kill in excess of 8,000 people.

From the United States Congress, Office of Technology Assessment, 1993, Proliferation of Weapons of Mass Destruction: Assessing the Risks. OTA-ISC-559, August, p. 53-54

Production and Dissemination

High technology is not an absolute necessity for biological weapons (as the historical examples illustrate); but certain technological capacities are usually required for a large scale biological attack. The production of biological weapons usually involves large quantity production of the agent (which, with appropriate facilities, can be accomplished on short notice), their placement in effective delivery systems, especially if the aim is to cover large areas, and stabilization of the agent so the it maintains its pathogenic characteristics despite factors such as light, oxidation, heat, etc during storage, delivery and dissemination. The anthrax strain that was used in the recent attacks in the United States was isolated in Texas and it is still present in nature. With knowledge and some patience, the strain can be collected by anyone. The conversion of the bacteria into a viable weapon, however, is a more complex and difficult process, whose difficulty is largely proportional to the lethality, stability, and dispersion of the weapon that is desired.

There are, however, exceptions. Easily transmissible diseases, particularly those for which the target population has little or no resistance, can require little in the way of production skills. The (apparently accidental) recent outbreak of foot and mouth disease in the United Kingdom is illustrative. Similar human effects may be possible with certain diseases easily passed from person to person. Genetic uniformity in agriculture contributes to its vulnerability to attack with such agents.

The Biotechnology Revolution and Biological Weapons

Practically every major new technology in history has been heavily exploited for military purposes. Considering the far reaching implications of genetic techniques, the ability to modify fundamental life processes, and their possibilities for both peaceful and hostile applications, it is crucial to avert the hostile exploitation of modern biotechnology through legal prohibitions ***and*** precautionary biosafety approaches. The strong international norm against biological weapons is increasingly deteriorating, with a prospect of opening

a new biological arms race based on biotechnology. Preventing this possibility will require regulation of biotechnology and enforcement of the norm against biological warfare to work hand in hand.

Technological development has played an important role in the development of biological weapons. The expansion of microbiology at the turn of the Twentieth Century enabled the production of biological weapons during First World War, making it possible to produce microorganisms in large quantities and deliver them in military operations. Further refining of these techniques were major activities of World War II and Cold War biological weapons programs. Advances in molecular biology in the 1970s in turn, made it possible to insert genetic material from one species to a different one, and to transfer a specific trait or characteristic. For biological weapons, this opened up the possibility of moving "military" traits between species to enhance existing agents, or even to create entirely new weapons.

By the 1980s, the military implications of genetic engineering had come more closely into focus. In a 1989 article in the (US) Naval War College Review, a US strategic thinker declared "***The outlook for biological weapons is grimly interesting. Weaponeers have only just begun to explore the potential of the biotechnological revolution. It is sobering to realize that far more development lies ahead than behind***."[3] Shortly thereafter, the veil of secrecy surrounding the former Soviet Union's offensive biological weapons program began to recede and Western researchers – particularly in the US – began to seriously explore the military potential of biotechnology in parallel (and now, increasingly in cooperation) with their commercial counterparts. Many possibilities for the abuse of genetic engineering to create weapons have emerged. Examples are provided in the following section.

Genetic engineering of classical biowarfare agents

It is obvious that genetic engineering could easily be abused to construct more effective biological weapons. Anthrax and plague are already very dangerous and lethal diseases, but from a bioweaponeers point of view they are less than optimal to serve military purposes. Genetic engineering may help to change this. Microorganisms can be made resistant to antibiotics or vaccines, even more lethal, easier to handle, harder to detect, or more stable in the environment. The following real-world examples show that this is not science fiction but already a deadly reality:

Y. pestis, causative agent of the Plague.

"Invisible" Bioweapons In the 1990s, Russian researchers succeeded in altering the immunological properties of anthrax, making existing vaccines and detection methods ineffective against the new genetically engineered types.[4] Russian researchers also developed a new vaccine that is effective against the artificial strain. Following the Russians, the US Department of Defense is now also genetically engineering anthrax. According to the US, the secret experiments are to test if the Russian microbe can defeat the US anthrax vaccine.

Drug-Resistant Bioweapons: The German Army's Institute for Microbiology in Munich works with tularemia bacteria that are genetically altered to withstand antibiotic treatment. Tularemia is a top candidate for biological warfare and has been weaponized in several offensive programmes. According to the German Ministry of Defense, this project is basic research to better understand tularemia biology. The bacteria were equipped with the gene for a fluorescent protein to follow the infection pathway of the bacteria. As a so called marker, a second gene was introduced that codes for a resistance against the antibiotics tetracycline and chloramphenicol. The rationale behind this experiment might have been defensive, but at the same time the pathogens were conferred a better offensive potential as they could no longer be treated with these antibiotics.

Making Harmless Microbes Deadly: Genetic engineering can turn a previously harmless bacteria into a lethal biological weapon by introducing deadly genes from a pathogenic organism. This was done by US

[3] See Meselson M. *Averting the Hostile Exploitation of Biotechnology*, CBW Conventions Bulletin, June 2002, p. 16.
[4] Pomerantsev AP, et al. 1997. *Expression of cereolysine ab genes in Bacillus anthracis vaccine strain ensures protection against experimental hemolytic anthrax infection*. Vaccine 15:1846-1850

researchers as early as 1986. They isolated the gene for the lethal factor of anthrax and introduced it into ***Escherichia coli***, a normally harmless gut bacteria. The US team reported that the lethal factor protein was active in the gut bacteria and displayed the same deadly effects as it does in its native ***B. anthracis***.[5]

Cloned Toxin Genes: The cloning of toxin genes in bacteria makes it possible to produce formerly rare toxins in large quantities. Also covered under the Chemical Weapons Convention, toxins include many of the deadliest substances on earth and pose threats to humans, animals, and plants.

Laboratory Experiments and Misadventures Lead to Deadly Discoveries

By pure accident, poor biosafety regulation, poor scientific judgement, or malicious intent, genetic engineering may give rise to new and unforeseen organisms that pose a serious risk to the environment and human health and which at the same time may be abused for hostile purposes.

Mousepox Blueprints an Extraordinarily Dangerous Weapons: A recent experiment with mousepox in Australia created an extremely lethal genetic engineered virus when they added a gene believed to be "harmless". The gene, which codes for an immune system protein, actually suppressed the immune systems of mice exposed to the virus. The effect was so strong that even half the mice vaccinated against mousepox dies from the disease. Other studies suggest that a similar approach may have similar effects with human smallpox and other related viruses.[6]

Hybrid "Dengatitis": In 2001, British researchers pled guilty to charges that they improperly handled a genetically engineered hybrid of the viruses causing hepatitis C and dengue fever. British authorities characterized the virus as "***more lethal than HIV***"[7] "Dengatitis" was deliberately created by researchers who wanted to use fewer laboratory animals in a search for a vaccine for hepatitis C. Under unsafe laboratory conditions, the researchers created and nearly accidentally released a new hybrid human disease whose effects, fortunately, remain unknown; but which may have displayed different symptoms than its parents and thus been difficult to diagnose, and have required a new, unknown treatment regime (if treatable at all).

Other "Superviruses" A variety of additional examples highlight how little is known about viral genetics and immune response. This makes any genetic engineering approach a gamble that could create new deadly strains that pose biosafety and bioweapons risks. Examples abound. Researchers in Germany engineered the Ebola virus to study the mechanisms underlying the high pathogenicity of this particularly dangerous virus. It came as a surprise that the virus became more toxic to human cells when part of one gene was eliminated. It turned out that researchers had eliminated the part of the virus that downregulates toxicity.[8] In another case, Japanese researchers combined genes of the human AIDS-causing virus (HIV) with a similar monkey virus (SIV) and added a gene that plays a role in the human immune system. The immune system gene stimulated replication of the genetically engineered virus in the test tube and, according to the researchers, will "***have an effect on viral replication and pathogenicity***" in humans.[9]

New Types of Weapons

Modern biotechnology also allows the adaptation or creation of new types of biological weapons particularly suited to the types of conflicts and military interventions prevalent since the end of the Cold War. Ethnic conflicts have flared, as have conflicts between the West and smaller states. The "Drug War", "Peacekeeping", "Military Operations Other Than War" and the "War on Terrorism" are new (or rejuvenated) names for armed conflicts that blur the line between law enforcement and military action. In response, new types of armaments have been developed or proposed, including biological weapons.

Anti-Material Biological Weapons: At the US Naval Research Laboratory, researchers are isolating natural microorganisms that degrade a variety of materials (plastics, rubber, metals, etc.) and then using genetic

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[5] Robertson DL, Leppla SH 1986. *Molecular cloning and expression in Escherichia coli of the lethal factor gene of Bacillus anthracis*. Gene 44(1):71-8

[6] For more information, see *New Scientist*, 13 January 2001 and "Genetic Engineering Super-viruses", *Isis News*, July 2001 (www.isis.org.uk).

[7] Arthur C "*Scientists made virus 'more lethal than HIV'*, The Independent, 24 July 2001.

[8] Volchkov VE, et al. (2001) Recovery of Infectious Ebola virus from complementary DNA: DNA Editing of the GP gene and viral cytotoxity. Science 291: 1965-1969

[9] Kosyrev, Miura T, Haga T, Kuwata T and Hayami M. Construction of SIV/HIV-1 chimeric virus having the IL-5 gene and determination of their ability to replicate and produce IL-5. Arch Virol 2001, 146,1051-62.

engineering to make them more powerful and focused. According the British government, such technologies "***clearly have potential for development as a means of warfare or for hostile use against material crucial for normal civilian life***."[10] One genetically engineered microbe can destroy plastic-based military aircraft coatings in 72 hours. Possible applications have been described by the principal investigator at the Naval Research Lab, among them: "***It is quite possible that microbial derived or based esterases might be used to strip signature-control coatings from aircraft, thus facilitating detection and destruction of the aircraft.***"[11] The US Navy work is purportedly defensive, although no threat has been articulated and ongoing research by the Navy and Army continue to stride towards taking these weapons from the laboratory to the field, including development of "terminator technology" systems to facilitate the release of such anti-material microbes.[12]

Agent Green – Biological Weapons in the Drug War: About a decade ago, the United States increased efforts to identify microorganisms that kill drug-producing crops. In the late 1990s, this research focused largely on two fungi. Testing of ***Pleospora papaveracea*** to kill opium poppy, conducted in Uzbekistan with US financing and scientific support, was completed in 2001. Pathogenic ***Fusarium oxysporum*** strains developed in the United States to kill coca plants were scheduled for field testing in Colombia in 2000, but international protests led to a (possibly temporary) halt to this project. These fungi provide a quintessential case of the hostile use of biological agents. In Colombia, with its ongoing civil war, the situation is obvious. The biggest areas of coca and opium poppy cultivation are in combat zones, and the 'War on Drugs' in Colombia is part of the ongoing armed conflict.

To overcome the obvious conflict that using biological agents by force in the midst of an armed conflict has with the Biological Weapons Convention, proponents of biological drug eradication have argued that use of these fungi is not biological warfare, but 'biological control', a technique for weed and pest control in sustainable agriculture. However, this label has been fiercely criticised by scientists in the field who stated in 2001:

> ***We strongly reject any equation of legitimate biological control and the use of biological agents in drug eradication and want to emphasize that legitimate biological control is environmentally safe and should never be used without the consent of farmers and ranchers…***[13]

Biological control seeks to protect a crop from pests and diseases, not to kill one that is by no definition a weed. It seeks to regulate populations of agricultural pests within manageable parameters, not to eradicate cultivated crops.

These agents are lowering the political threshold for use of biological weapons and are likely to have tremendous environmental and health impacts. Pursuit of crop-killing fungi or materiel-degrading microbes as weapons would be a step down a slippery slope, that, following the same logic, could lead to the use of other plant pathogens, animal pathogens, or even biological weapons against humans.[14]

Terminator technology and beyond

While the above examples are already under development, the future may hold even more malign uses of biotechnology. Terminator technology that renders seed infertile to guarantee seed corporations' yearly sales may eventually be abused for economic warfare. If terminator crops become widespread, it would be easy for a transnational company that controls the technique to stop sales to a specific country or region for political or economic purposes. After some years of planting such seeds, only limited quantities of other seed would be available, thus agriculture could be paralyzed, leading to serious economic crisis and/or famine.

Many other new – and from today's perspective unthinkable – weapons will follow. New understandings of the interaction between plants and their diseases will enable genetic engineering of improved anti-crop weapons. The deciphering of the human genome, synthetic genes and organisms, new approaches to gene

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[10] Submission of the British government to the BTWC 5th Review Conference, document BWC/CONF.V/4/Add.1.
[11] Campbell J. *Defense against biodegradation of military materiel.* Presentation at the 3rd Non-lethal Defense Symposium, February 1998. http://www.dtic.mil/ndia/NLD3/camp.pdf
[12] For a more comprehensive report on anti-material microbes, please see the Sunshine Project, Genetically Engineered Anti-Material Weapons, Backgrounder Series #9, March 2002.
[13] Warning against the use of biological agents in forced drug eradication. Statement by more than 25 international experts on biological control. April 2000.
[14] For a more comprehensive description of this issue, please see *Risks of Using Biological Agents in Drug Eradication,* Sunshine Project Backgrounder #4, February 2001.

therapy or drug delivery, and the manifold genetic engineering experiments with potentially pathogenic microorganisms will increase the availability of sophisticated biological agents with a potential for hostile use.

Observations on Corporations, Biotechnology, Genetic Diversity, and Agricultural Bioweapons

From Agricultural Biowarfare and Bioterrorism by Dr. Mark Wheelis (Section on Microbiology, University of California at Davis), Edmonds Institute Occasional Paper, 2000. Online at http://www.edmonds-institute.org

Agricultural corporations, including producers, processors, and shippers, could benefit immensely from the economic impacts, market share changes, and financial market effects of a successful biological attack. Many also employ expert plant pathologists or veterinarians and have large collections of pathogens. The combination of motivation, expertise, and materials within a single, closed organization is worrisome. Of course, corporations, like countries, would run enormous legal risks if they perpetrated a biological attack, so if they were to choose to do this, it would be expertly designed to mimic a natural outbreak or to appear to be the work of others.

For both corporations and governments, decision to use bioweapons would be expected to require approval at the very highest level, thus reducing its likelihood. However, in both, the possibility of mid- or lower-level zealots initiating unauthorized action has to be considered...

Agriculture is highly vulnerable to genotype-specific weapons

Agriculture, particularly in many developed countries, has several properties that make it vulnerable to attack with genotype-specific weapons. Typically, it employs monocropping of large acreages with genetically identical cultivars, and high-density husbandry of genetically inbred animal strains. These agronomic practices reduce the genetic variability that makes populations resistant to genotype-specific weapons, and thereby create conditions (large, dense populations) that facilitate disease spread.

The International Ban on Biological Weapons

Not all methods of warfare are permitted. Although international law recognizes the right of states to wage war based on the principles of sovereignty and self-defense, the right of states to engage in armed conflict is not absolute. The Law of War prescribes restrictions on three aspects of armed conflict: the definition of war, relations between neutral and belligerent states, and the conduct of war, that is, weapons, treatment of prisoners, wounded, civilians in occupied territories, enemy nationals and their property, and non-military ships.[15]

The first international treaty in modern law banning the use of biological weapons was the 1925 ***Protocol for the Prohibition of the Use of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare***, known as the Geneva Protocol. Negotiated under the auspices of the League of Nations after the First World War, the Geneva Protocol had significant shortcomings: its prohibition did not cover production, development and stockpiling of biological (and chemical) weapons and many countries reserved the right to retaliate with biological weapons. So, even after ratifying the Protocol, many industrialized countries continued to build arsenals of chemical and biological weapons, which were used to cause extensive harm, particularly in colonial wars in the South, for example Italy's massive use of chemical weapons during its 1934-35 attack on Ethiopia.

In the 1950s the UK and, in late 60s the US, both renounced the use and development of biological weapons, removing major stumbling blocks to the development of a more comprehensive multilateral ban. The result was the 1972 ***Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction*** (BTWC). To date, 144 states have become Parties (see Annex II).

Unlike the Geneva Protocol's ban on use, the BTWC bans development, production and stockpiling, acquisition or retention of biological agents or toxins "***whatever their method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes***". The ban also extends to "***weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict***."

The Convention defines biological weapons with the so-called "general purpose criterion". The criterion does not prohibit specific living organisms or their byproducts. Instead, it prohibits their development for hostile

[15] Henkin, L, et al. 1998. International Law: Cases and Materials, West Publishing, St. Paul, p. 802

purposes. This is because biological agents have dual uses: all organisms, even dangerous ones, might be used in a peaceful way. Likewise, nearly all the know-how and equipment necessary for an offensive biological warfare program has applicability to civilian biological research.

For example, botulinum toxin ("bot tox") is both a dangerous biological weapon and (because of its effects on muscle) an increasingly popular cosmetic drug for removing wrinkles from the faces of Hollywood stars and the wealthy. Commercial bot tox products pose no biological weapons threat (the quantities of toxins are too low); but the facilities that produce pharmaceutical bot tox would require little modification in order to produce bot tox for weapons. Thus, whether a given activity is offensive or peaceful is a largely matter of intent.

By becoming Parties to the BTWC, countries commit to destroy or divert to peaceful uses all banned biological agents and equipment; to take any necessary measures to ensure that the provisions of the Convention are observed domestically, and to cooperate and facilitate the fullest exchange of equipment, materials, scientific and technological information for the use of biological agents and toxins for peaceful purposes. States Parties complaints regarding compliance with the Convention are addressed to the Security Council.

Unfortunately, the treaty lacks a mechanism to verify compliance with its provisions. Beginning in 1994, States Parties tried to overcome this shortcoming through the negotiation of a ***Verification Protocol.*** The protocol would provide a framework to ***enhance transparency*** among states, for international ***declaration*** of modern biotechnology facilities that might be related to biological weapons research or could be misused for production of biological weapons (this includes all such facilities, government, academic, commercial, etc.); ***random visits*** by international inspection teams at declared facilities, a ***clarification process*** when declarations are unclear or incomplete, and for ***challenge investigations*** conducted when production, stockpiling or use of biological weapons is suspected.

Pillars of a System that Isn't

Because of US opposition, it appears unlikely that the BTWC Verification Protocol close to its current form will materialize; but the composite text developed by negotiators, though imperfect in many aspects, shows how compliance with the BTWC could be enhanced through increased transparency. The text is long; but the general approach is straightforward, focusing on existing biotechnology facilities and relying on measures to enhance transparency. The concept rests on four pillars:

· **Declarations**: Industrial, government (including military), and academic biotechnology facilities that might be related to bioweapons research or could be abused for bioweapons production were to be declared by each State Party. An "Organisation for the Prohibition of Biological and Toxin Weapons" would have been established to receive the declarations and govern all other measures provided for by the Protocol.

· **Inspections** (or "visits") at the declared facilities would have helped to control the correctness of the declarations and to enhance transparency between States. International inspectors from the Organisation would have performed the inspections. Preferably, the visited facilities would have been selected randomly from all declared facilities.

· A **clarification** process was planned in case a declaration was unclear, or if it were suspected that a declaration was incomplete or that a facility that ought to have been declared was not. This was intended in some way as an intermediate step before a (politically costly) formal investigation.

· **Investigations**: The strongest procedure would have been a challenge investigation, conducted in the case of suspicion being voiced by a Party alleging possible production or use of biological weapons in another country.

Such a protocol would have been a major step forward to put teeth the BTWC and enhance compliance. The approach is far from perfect and it alone would not be sufficient to completely deter the development, production or use of bioweapons. But it would make it very challenging and expensive to build an offensive program in secrecy and would thus serve an important deterrent role.

After more than two dozen negotiating sessions, talks on the Verification Protocol were suspended in November 2001 when the United States declared that would not support, and not permit the conclusion of a binding multilateral verification agreement. Among the reasons that US officials cited for the refusal was that the US believes that other countries are cheating ***and*** that the US should not be subject to the same standards as the rest of the world, and that the intellectual property of the US biotechnology industry would

be put at risk by spying inspectors.[16] This rupture with other States Parties carried over to the BTWC's Fifth Review Conference, in November-December 2001. At that meeting, in the final hours, the US suddenly insisted on language to completely terminate the mandate of the group negotiating the Verification Protocol. This angered the rest of the world, leading to an impasse and the suspension of the Conference until November 2002.

While it is theoretically possible for BTWC States Parties to use the voting procedure to restart talks on mandatory verification, voting is seldom used in disarmament and this possibility is regarded as very unlikely. Most States Parties believe that US biotechnology and military strength is such that the US must be included in the multilateral inspection system in order for it to be effective.

As of April 2002, the fate of the renewed 5th Review Conference of the BTWC remains very unclear. The block on verification talks could lead to another negotiating collapse, and a failure to produce a Final Declaration. If the US remains particularly belligerent to the idea of opening its facilities to inspection, this could even lead to cancellation of the meeting before it starts. US actions in its war on terrorism could also precipitate postponement of the talks. If the meeting convenes as scheduled (in Geneva in November), the most likely result is a compromise solution that places legally binding options on the back burner while initiating political processes through new expert groups and, possibly, (annual) Conferences of the Parties to the BTWC. The US will seek to restrict these talks to technical matters unlikely to lead to significant new binding commitments on biological weapons control.

Dual Use Dilemmas

A key problem in biological arms control is the dual use of the know-how and equipment involved in civilian research, biodefense projects and in offensive biowarfare programs. It is especially difficult to draw clear lines between offensive and defensive research. In the course of many biodefense projects, an offensive capability is generated. For example, to test detection systems for biological weapons, the infectious agents are often produced and dispersed, thereby developing skills and generating information useful for offensive biological warfare. Similarly, a vaccine against anthrax or plague (or other biological weapons agents) is not only a defensive tool; it can also support the development of an offensive capability.

There is little point in arguing generally against all biodefense research. Any development in the biomedical sciences – be it the development of a new drug, a new technique or genome sequencing tools – might be applied to fight off a biological attack and may thus be considered "biodefense" research. Although there are obviously big differences between the development of a new drug and the production of lethal anthrax spores, both of these activities have been subsumed under biodefense in both popular and government terminology, making it hard to draw a clear line between prudent biomedical research and counterproductive projects that endanger international security.

The BTWC circumvented this problem through the "general purpose criterion", which prohibits biological agents and toxins "***that have no justification for prophylactic, protective or other peaceful purposes***". This means that even the minute amount of one microgram of botulinum toxin would be prohibited under the Convention if it were produced with the intent to kill somebody. But even a million times the amount of the same toxin is not banned if it is intended for medical uses.

The beauty of the general purpose criterion is that any kind of development and production for hostile purposes is prohibited, with no exceptions. It also covers unknown future technologies, as it relies on purpose, rather than the identification of specific items. The general purpose criterion must be considered an important strength of the BTWC and must not be weakened in any way.

There are, however, several serious downsides of this approach. Verification is problematic, as it is difficult to control intent (as opposed to tangible items like facilities or warheads); the exemption for "protective" purposes opens abundant space for abuse.

[16] On this latter point (and others), Europe disagreed. European countries conducted mock inspections of biotechnology facilities of a type likely to be required by the Verification Protocol. They concluded that intellectual property would **not** be put at risk by the inspection regime. NGOs pointed out that even if a very aggressive inspection regime posed minor risks to intellectual property, that this is more than acceptable price to pay for dramatically decreasing the chance of a biological arms race.

The dual-use ambiguity is being exploited by some countries to create ever greater definitions of what is an acceptable "biodefense" project. The US has been especially creative in this regard. In September last year and following the anthrax attacks, several US biodefense projects became public which stretch the limits of the BTWC and – in some cases –violate it. These include testing of mock biological bombs, explosive testing of aerosols, and production of weapons-grade anthrax.[17] In the wake of the anthrax attacks, the US Congress has approved spending over US $10,000,000,000 for biodefense studies.

Biosafety and Biosecurity – Linkages and Synergies

The Bioweapons Convention is – on paper – a strong instrument that is three decades old. The Cartagena Biosafety Protocol is a new instrument recently developed to address certain problems related to modern biotechnology and which is gathering ratifications for entry into force. Biotechnology has presented the BTWC with serious problems that have been recognized by States Parties;[18] but which they have been unable to successfully address.

This reality is recognized by all parties to the BTWC. Even those with the greatest profit interest in genetic engineering are calling for dramatic new biosafety measures. In a November 2001 statement on biological weapons, US President George Bush called for "***sound national oversight mechanisms for the security and genetic engineering of pathogenic organisms***", and "***responsible conduct in the study, use, modification, and shipment of pathogenic organisms***".[19] At the 5th Review Conference of the BTWC, the normally regulation-averse US reiterated its call for new and "***strict biosafety procedures***" and "***national oversight of high-risk*** [genetic engineering] ***experiments***".[20]

Some Key Commonalities and Shared Concerns of the Biosafety Protocol and the BTWC

Subject The BTWC addresses all biological weapons, genetically modified or not. The Cartagena Biosafety Protocol addresses living modified organisms. The Biosafety Protocol is concerned with a major subset (but not all) of the BTWC's subject matter: those organisms that are genetically modified.

Purpose The purpose of the Biosafety Protocol is to ***"prevent or reduce risks to biological diversity, taking also into account risks to human health [from] development, handling, transport, use, transfer and release of any living modified organisms."*** The BTWC prohibits development, production, stockpiling, acquisition, and retention of all biological weapons. A number of parallels in the purposes of the instruments are apparent.

Method The BTWC, through the General Purpose Criterion, imposes limits on all research with biological agents. The criterion establishes that types and quantities of all biological agents that are not justifiable for peaceful purposes are illegal. The Biosafety Protocol fully accepts the Precautionary Approach that stipulates that lack of scientific certainty shall not prevent governments from taking a decision to avoid adverse effects. Neither the General Purpose Criterion nor the Precautionary Approach is limited to prohibiting specific activities. Rather, both use the method of applying a sound general principal to a wide variety of scientific activities with a view to eliminating or limiting those that are threatening. Harmonies can be appreciated between these key general principals of the two instruments.

Human Health A cornerstone of international arms control law, including the BTWC, is the protection of non-combatants from harm by indiscriminate weapons. In the case of the BTWC, this cornerstone is carried further to the total prohibition of a class of weapons. The Cartagena Biosafety Protocol originates in CBD's objective of the conservation, sustainable use, and equitable sharing of benefits from biological diversity. It adds, in its objective, general provisions, and scope, that biosafety law will also take into account risks to

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[17] See, for example, *U.S. Germ Warfare Research Pushes Treaty Limits*, New York Times, 4 September 2001 and *Bioterror: Organisms made at a military laboratory in Utah are genetically identical to those mailed to members of Congress*, Baltimore Sun, 12 December 2001.

[18] At the BTWC 5th Review Conference and in prior meetings, many governments have acknowledged that proliferation of biotechnology and related knowledge is accelerating biological weapons threats. See, for example, the Background Paper submitted by the United Kingdom for the BTWC 5th Review Conference, BWC/CONF.V/4/Add.1, available online at http://www.opbw.org.

[19] US President George W. Bush. *President's Statement on Biological Weapons*, 1 November 2001. URL: www.whitehouse.gov/news/releases/2001/11/20011101.html

[20] Bolton J (US Under Secretary of State for Arms Control and International Security), *Intervention at the 5th Review Conference to the Biological and Toxin Weapons Convention*, 19 November 2001.

human health. This special provision in the Biosafety Protocol enhances its relevance to the BTWC. Thus in addition to the concern that both instruments share with protection of animals and plants, there is a common interest in human well-being.

Coverage Pursuant to the mandate from the Convention on Biological Diversity, the operational provisions of the Biosafety Protocol are largely related to transboundary movement of genetically modified organisms and do not apply, for example, to organisms for contained use. By contrast, the BTWC applies to all biological weapons agents regardless of their location or type. Some (prospective) Parties to the Biosafety Protocol, including African and European countries, are designing and implementing biosafety legislation which goes beyond that minimally required by the Biosafety Protocol, addressing issues such as contained use in the same regulatory framework as that developed specifically in response to Biosafety Protocol requirements on transboundary movement. Foundation for this approach to broader implementing legislation is contained both in the objective, general provisions, and scope of the Biosafety Protocol (Articles 1, 2 para 4, and 4) and in Article 19 of the Convention on Biological Diversity, which gave rise to the agreement. These refer to "***any living modified organism***" with biodiversity impacts.

Organism Movement There is a strong relationship between the BTWC's prohibitions on transfer and acquisition (non-proliferation) of biological weapons and the Biosafety Protocol's focus on transboundary movement of genetically modified organisms. Both require Parties to take steps to ensure that genetically modified organisms entering and leaving their borders not be used to cause harm to people, animals, and plants. This relationship offers many possibilities of synergies in implementation of the agreements leading to higher levels of biosafety and protection from biological weapons. Concrete steps related to this relationship should be among the first taken to create cooperation between the agreements.

Technology Transfer The BTWC's Article X requires States Parties to "***undertake to facilitate… the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes."*** The Cartagena Biosafety Protocol and the Convention on Biological Diversity also contain obligations for transfer of technology, including biotechnology and that related to biosafety. Always a contentious issue, the technology transfer debate has played out in very different ways between the instruments, despite the similarities in the obligations imposed. Nevertheless, both instruments contain the obligation to develop transfer systems that are safe, fair, and which adequately take into account the provisions both agreements contain related to developing countries.

A Continental Step in the Right Direction:
African Model Law Criminalizes Hostile Use of GMOs

The approach taken by the African Union (AU) in its Model Law on Safety in Biotechnology is an example of how implementation of the Biosafety Protocol can create more robust and comprehensive legislation to prevent hostile use of biotechnology.

Adopted at the AU's July 2001 summit in Lusaka, the Model Law criminalizes the use of genetic engineering for hostile purposes. Penalties include incarceration and fines, and apply to persons, organizations, and corporations. If a corporation is responsible, its chief executive officer may be held accountable. In addition, African courts may prohibit anyone convicted of violating the law from conducting future biotechnology research.

The criminal sanctions in the Model Law are applicable to persons who create or use GMOs that damage "*human health, biological diversity, the environment, or property*". This means that protection is provided for people, plants, crops, soils, and the natural and built environment, including items such as foodstuffs, vehicles, shelter, buildings, and other property and infrastructure.

Africa's Model Law is proactive and does not only apply after damage is done. It covers multiple phases of biological weapons research and use by prohibiting "*development, acquisition, application, or deliberate release*" of a GMO – or a product thereof - with the intention of causing harm. Coupled with the transboundary movement regulations of the Model Law, enacting the provisions on hostile use will give African countries an important tool to detect, prevent, and punish the entry of biological weapons. Governments in other regions should strongly consider following Africa's lead.

The list of relationships between the Biosafety Protocol and the BTWC is not exhaustive, and more will become apparent as the instruments are further implemented, for example, in capacity building, exchange of information, and in concrete activities related to recognition and monitoring of agents. In particular, as the

Biosafety Protocol's implementation is further negotiated, relationships may emerge in liability and enhanced roles that the Protocol's Competent National Authority(ies) may play in assisting compliance with the BTWC.

Preliminary Recommendations

As the Cartagena Protocol enters into force and the BTWC moves towards more frequent political discussions, further development of concrete relationships is required. Even at this early stage, however, a number of actions should be taken:

1) The Intergovernmental Committee for the Cartagena Protocol (ICCP) on Biosafety should request observer status for the Protocol at meetings of the Biological and Toxin Weapons Convention. Any future organization to support the BTWC should likewise apply for observer status with the Biosafety Protocol.

2) Training courses and capacity building for the Cartagena Biosafety Protocol should include components on biological weapons and biological weapons control. Governments, particularly developed countries, should assess how support for Biosafety Protocol capacity building may contribute to fulfilling their obligations under the BTWC.

3) National (and regional) implementation of the Biosafety Protocol and the Biological and Toxin Weapons Convention should be pursued together and, to the maximum extent possible, within the same or a linked legal framework.

4) National biosafety law should create criminal penalties for the hostile use of genetically modified organisms. These penalties should apply to all persons, including individuals, government officials (in private and official capacities), corporations, and other organizations.

5) The ICCP should examine relationships between the Cartagena Biosafety Protocol and the BTWC, and recommend that the First Meeting of the Members of the Protocol to begin with a study of how the Protocol's requirements on transboundary movement of LMOs relate to non-proliferation of biological weapons.

ANNEXES

1. Suggested Reading

Anuradha RV. ***Transfer of Biological Resources under the Biodiversity Convention and the Biological Weapons Convention***, Review of European Community and International Environmental Law 8:2 125-134, 1999.

British Medical Association Biotechnology, Weapons, and Humanity, Harwood Academic Publishers, 1999.

Mauro F. ***Possible Linkages Between the Cartagena Biosafety Protocol and the Biological and Toxin Weapons Convention***, conference paper for Biosecurity and Bioterrorism, Istituto Diplomatico "Mario Toscano", Rome, 18-19 September 2000. URL: http://lxmi.mi.infn.it/~landnet/Biosec/mauro.pdf

Meselson M. ***Averting the Hostile Exploitation of Biotechnology***, CBW Conventions Bulletin, Number 48, June 2000. URL: http://fas-www.harvard.edu/~hsp/bulletin/cbwcb48.pdf

United Kingdom. ***Background Document On Compliance By States Parties With All Their Obligations Under The Convention On The Prohibition Of The Development, Production And Stockpiling Of Bacteriological (Biological) And Toxin Weapons And On Their Destruction***, BWC/CONF.V/4/Add.1. URL: http://www.brad.ac.uk/acad/sbtwc/btwc/rev_cons/5rc.html.

Wheelis M. ***Agricultural Biowarfare and Bioterrorism***, Edmonds Institute Occasional Paper, 2000. URL: http://www.edmonds-institute.org/wheelis.html

Other Resources:

The CBW Conventions Bulletin, published quarterly by the Harvard-Sussex Program on CBW Armament and Arms Limitation (online at http://fas-www.harvard.edu/~hsp/pdf.html) provides articles and detailed chronologies of biological weapons control news.

The website www.opbw.org, maintained by the Peace Studies Department of Bradford University, provides official BTWC documents including papers from its Review Conferences and the negotiation of the Verification Protocol.

2. The Biological and Toxin Weapons Convention and its States Parties

CONVENTION ON THE PROHIBITION OF THE DEVELOPMENT, PRODUCTION AND STOCKPILING OF BACTERIOLOGICAL (BIOLOGICAL) AND TOXIN WEAPONS AND ON THEIR DESTRUCTION (BTWC)

Entered into force 26 March 1975

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and their elimination, through effective measures, will facilitate the achievement of general and complete disarmament under strict and effective international control,

Recognizing the important significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on June 17, 1925, and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the principles and objectives of that Protocol and calling upon all States to comply strictly with them,

Recalling that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and objectives of the Geneva Protocol of June 17, 1925,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Desiring also to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Convinced of the importance and urgency of eliminating from the arsenals of States, through effective measures, such dangerous weapons of mass destruction as those using chemical or bacteriological (biological) agents,

Recognizing that an agreement on the prohibition of bacteriological (biological) and toxin weapons represents a first possible step towards the achievement of agreement on effective measures also for the prohibition of the development, production and stockpiling of chemical weapons, and determined to continue negotiations to that end,

Determined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Have agreed as follows:

Article I

Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

(1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;

(2) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

Article II

Each State Party to this Convention undertakes to destroy, or to divert to peaceful purposes, as soon as possible but not later than nine months after the entry into force of the Convention, all agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, which are in its possession or under its jurisdiction or control. In implementing the provisions of this article all necessary safety precautions shall be observed to protect populations and the environment.

Article III

Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified in article I of the Convention.

Article IV

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent the development, production, stockpiling, acquisition, or retention of the agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

Article V

The States Parties to this Convention undertake to consult one another and to cooperate in solving any problems which may arise in relation to the objective of, or in the application of the provisions of, the Convention. Consultation and cooperation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

Article VI

(1) Any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council.

(2) Each State Party to this Convention undertakes to cooperate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

Article VII

Each State Party to this Convention undertakes to provide or support assistance, in accordance with the United Nations Charter, to any Party to the Convention which so requests, if the Security Council decides that such Party has been exposed to danger as a result of violation of the Convention.

Article VIII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on June 17, 1925.

Article IX

Each State Party to this Convention affirms the recognized objective of effective prohibition of chemical weapons and, to this end, undertakes to continue negotiations in good faith with a view to reaching early agreement on effective measures for the prohibition of their development, production and stockpiling and for their destruction, and on appropriate measures concerning equipment and means of delivery specifically designed for the production or use of chemical agents for weapons purposes.

Article X

(1) The States Parties to this Convention undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes. Parties to the Convention in a position to do so shall also cooperate in contributing individually or together with other States or international organizations to the further development and application of scientific discoveries in the field of bacteriology (biology) for prevention of disease, or for other peaceful purposes.

(2) This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international cooperation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of the Convention.

Article XI

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party on the date of acceptance by it.

Article XII

Five years after the entry into force of this Convention, or earlier if it is requested by a majority of Parties to the Convention by submitting a proposal to this effect to the Depositary Governments, a conference of States Parties to the

Convention shall be held at Geneva, Switzerland, to review the operation of the Convention, with a view to assuring that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realized. Such review shall take into account any new scientific and technological developments relevant to the Convention.

Article XIII

(1) This Convention shall be of unlimited duration.

(2) Each State Party to this Convention shall in exercising its national sovereignty have the right to withdraw from the Convention if it decides that extraordinary events, related to the subject matter of the Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Convention and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

Article XIV

(1) This Convention shall be open to all States for signature. Any State which does not sign the Convention before its entry into force in accordance with paragraph (3) of this Article may accede to it at any time.

(2) This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

(3) This Convention shall enter into force after the deposit of instruments of ratification by twenty-two Governments, including the Governments designated as Depositaries of the Convention.

(4) For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

(5) The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and of the receipt of other notices.

(6) This Convention shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XV

This Convention, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of the Convention shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding states.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Convention.

DONE in triplicate, at the cities of Washington, London and Moscow, this tenth day of April, one thousand nine hundred and seventy-two.

BTWC States Parties

Afghanistan
Albania
Argentina
Armenia
Australia
Austria

Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso

Cambodia
Canada
Cape Verde
Chile
China
Colombia
Congo
Congo, DR
Costa Rica
Croatia
Cuba
Cyprus
Czech Republic

Denmark
Dominica
Dominican Republic

Ecuador
El Salvador
Equatorial Guinea
Estonia
Ethiopia

Fiji
Finland
France

Gambia
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau

Honduras

Hungary

Iceland
India
Indonesia
Iran
Iraq
Ireland
Italy

Jamaica
Japan
Jordan

Kenya
Korea (DPR)
Korea (ROK)
Kuwait

Laos
Latvia
Lebanon
Lesotho
Libya
Liechtenstein
Lithuania
Luxembourg

Macedonia FYR
Malaysia
Maldives
Malta
Mauritius
Mexico
Monaco
Mongolia

Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway

Oman

Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal

Qatar

Romania
Russian Federation
Rwanda

Saint Kitts & Nevis
Saint Lucia
Saint Vincent & the Grenadines
San Marino
Sao Tome & Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
South Africa
Spain
Sri Lanka
Suriname
Swaziland
Sweden
Switzerland

Thailand
Togo
Tonga
Tunisia
Turkey
Turkmenistan

Uganda
Ukraine
United Kingdom
United States
Uruguay
Uzbekistan

Vanuatu
Venezuela
Viet Nam

Yemen
Yugoslavia, FR

Zimbabwe

3. The Australia Group Export Control Lists

Technology transfer under the BTWC (Article X) is a contentious issue. A group of mostly Northern countries allied in a club called the Australia Group maintain a common list of controlled items including equipment and pathogens. Export denials are determined in secret and often made without explanation. The South maintains that the Australia Group export controls are arbitrary and unfair, and that such systems should be truly multilateral.

Plant Pathogens

Bacteria

PB1. Xanthomonas albilineans

PB2. Xanthomonas campestris pv. citri

Fungi

PF1. Colletotrichum coffeanum var. virulans (Colletotrichum kahawae)

PF2. Cochliobolus miyabeanus (Helminthosporium oryzae)

PF3. Microcyclus ulei (syn. Dothidella ulei)

PF4. Puccinia graminis (syn. Puccinia graminis f. sp. tritici)

PF5. Puccinia striiformis (syn. Puccinia glumarum)

PF6. Pyricularia grisea / Pyricularia oryzae

Genetic Elements and Genetically-modified Organisms:

PG1 Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Core List.

PG2 Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Core List.

Technical note: Genetic elements include *inter alia* chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Items for Inclusion in Awareness-raising Guidelines

Bacteria

PWB1. Xanthomonas campestris pv. oryzae

PWB2. Xylella fastidiosa

Fungi

PWF1. Deuterophoma tracheiphila (syn. Phoma tracheiphila)

PWF2. Monilia rorei (syn. Moniliophthora rorei)

Viruses

PWV1 Banana bunchy top virus

Genetic Elements and Genetically-modified Organisms:

PWG1 Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Awareness-raising Guidelines.

PWG2 Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Awareness-raising Guidelines.

Technical note: Genetic elements include *inter alia* chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Animal Pathogens (1)

Viruses

AV1. African swine fever virus
AV2. Avian influenza virus2
AV3. Bluetongue virus
AV4. Foot and mouth disease virus
AV5. Goat pox virus
AV6. Herpes virus (Aujeszky's disease)
AV7. Hog cholera virus (*syn:* swine fever virus)
AV8. Lyssa virus
AV9. Newcastle disease virus
AV10. Peste des petits ruminants virus
AV11. Porcine enterovirus type 9 (*syn:* swine vesicular disease virus)
AV12. Rinderpest virus
AV13. Sheep pox virus
AV14. Teschen disease virus
AV15. Vesicular stomatitis virus

1. Except where the agent is in the form of a vaccine.

2. This includes only those Avian influenza viruses of high pathogenicity as defined in EC Directive 92/40/EC: "Type A viruses with an IVPI (intravenous pathogenicity index) in 6 week old chickens of greater than 1.2: or Type A viruses H5 or H7 subtype for which nucleotide sequencing has demonstrated multiple basic amino acids at the cleavage site of haemagglutinin''

Bacteria
AB3. Mycoplasma mycoides

Genetic Elements and Genetically-modified Organisms:

AG1 Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

AG2 Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

Technical note: Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Biological Agents (1)

VirusesV1. Chikungunya virus
V2. Congo-Crimean haemorrhagic fever virus
V3. Dengue fever virus
V4. Eastern equine encephalitis virus
V5. Ebola virus
V6. Hantaan virus
V7. Junin virus
V8. Lassa fever virus
V9. Lymphocytic choriomeningitis virus
V10. Machupo virus
V11. Marburg virus
V12. Monkey pox virus
V13. Rift Valley fever virus
V14. Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus)
V15. Variola virus
V16. Venezuelan equine encephalitis virus
V17. Western equine encephalitis virus
V18. White pox
V19. Yellow fever virus
V20. Japanese encephalitis virus

Rickettsiae
R1. Coxiella burnetii
R2. Bartonella quintana (Rochalimea quintana, Rickettsia quintana)
R3. Rickettsia prowazeki
R4. Rickettsia rickettsii

Bacteria
B1. Bacillus anthracis
B2. Brucella abortus
B3. Brucella melitensis
B4. Brucella suis
B5. Chlamydia psittaci
B6. Clostridium botulinum
B7. Francisella tularensis
B8. Burkholderia mallei (Pseudomonas mallei)
B9. Burkholderia pseudomallei (Pseudomonas pseudomallei)
B10. Salmonella typhi
B11. Shigella dysenteriae
B12. Vibrio cholerae
B13. Yersinia pestis

Toxins as follow and subunits thereof: (2)
T1. Botulinum toxins (3)
T2. Clostridium perfringens toxins
T3. Conotoxin
T4. Ricin
T5. Saxitoxin
T6. Shiga toxin
T7. Staphylococcus aureus toxins
T8. Tetrodotoxin
T9. Verotoxin
T10. Microcystin (Cyanginosin)
T.11. Aflatoxins

1. Except where the agent is in the form of a vaccine.
2. Excluding immunotoxins.
3. Excluding botulinum toxins in product form meeting all of the following criteria:
- are pharmaceutical formulations designed for human administration in the treatment of medical conditions;
- are pre-packaged for distribution as medical products;
- are authorised by a state authority to be marketed as medical products.

Genetic Elements and Genetically-modified Organisms:

G1 Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

G2 Genetic elements that contain nucleic acid sequences coding for any of the toxins in the list, or for their sub-units.

G3 Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

G4 Genetically-modified organisms that contain nucleic acid sequences coding for any of the toxins in the list or for their sub-units.

Technical note: Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

WARNING LIST

Viruses

WV1. Kyasanur Forest virus
WV2. Louping ill virus
WV3. Murray Valley encephalitis virus
WV4. Omsk haemorrhagic fever virus
WV5. Oropouche virus
WV6. Powassan virus
WV7. Rocio virus
WV8. St Louis encephalitis virus

Bacteria

WB1. Clostridium perfringens*
WB2. Clostridium tetani*
WB3. Enterohaemorrhagic Escherichia coli, serotype 0157 and other verotoxin producing serotypes
WB4. Legionella pneumophila
WB5. Yersinia pseudotuberculosis

Toxins as follow and subunits thereof:2

WT1. Abrin
WT2. Cholera toxin
WT3. Tetanus toxin
WT4. Trichothecene mycotoxins
WT5. Modeccin
WT6. Volkensin
WT7. Viscum album Lectin 1 (Viscumin)

* Australia Group recognises that these organisms are ubiquitous, but, as they have been acquired in the past as part of biological warfare programs, they are worthy of special caution.

1. Except where the agent is in the form of a vaccine.
2. Excluding immunotoxins.

Genetic Elements and Genetically-modified Organisms:

WG1. Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

WG2. Genetic elements that contain nucleic acid sequences coding for any of the toxins in the list, or for their sub-units.

WG3. Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the list.

WG4. Genetically-modified organisms that contain nucleic acid sequences coding for any of the toxins in the list or for their sub-units.

Technical note: Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.