Disarmament Forum, 2000-4
UNIDIR, October 2000

The Proliferation of Biological Weapons: A Threat Assessment

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Proliferation refers to the process of diffusion of weaponry and technology. Because of the 1925 Geneva Protocol banning the use of chemical and biological weapons (CBW) and the 1972 Biological and Toxin Weapons Convention (BTWC) most countries will not admit to having an active, dormant or even a past offensive biological weapon (BW) programme. Furthermore, the lack of in-depth case studies limits the understanding of how countries may set up BW armament programmes. The paucity of verifiable public information means that the BW proliferation debate will mainly rely on official statements or leaked information from intelligence agencies. Only a few states make such information more or less systematically available and they do so for domestic politics or in pursuit of certain international security interests.

These factors complicate the independent appraisal of the claims and the assessment methods. The absence of a definition of 'proliferation' in most analyses compounds the problem further. Consequently, there is no common understanding on when a country should be considered a proliferant state. Is a country a proliferator if it has the scientific, technological and industrial base to manufacture BW? Is the presence of a research and development programme the key indicator? Or, must a state be producing, stockpiling or deploying BW with military units to be a proliferator? The threat assessment is also negatively influenced by the perception of the enemy. Indicators that support pre-existing convictions will easily be included in the appraisal while counter-indicators will often be discarded as distracting from the true intent of that country. Factors that are objectively unrelated to the question of whether a country is acquiring a particular type of weaponry will feature in the proliferation assessment.

The burden of judgement lies with the proliferation analyst, who, invariably, will be influenced by his own social and cultural background. Different analysts may have different interpretations of the phenomenon and, therefore, value certain criteria differently. Intelligence or other governmental agencies of some countries often release lists of proliferators that vary in the names of states or in the judgement of the status of the programmes. Such variations also occur between the agencies of a single country. In summary, the lack of a definition of proliferation and corresponding assessment criteria means that no consensus can exist of when proliferation has occurred or when proliferation starts to pose a risk to international security.

Apart from these heuristic considerations, careful attention must also be paid to the source and quality of information. In proliferation studies, certainty of a BW programme will exist in only few cases: a country may publicly declare such programmes; physical evidence of such programmes, such as production and storage facilities or casualties from an incident, may be available; or

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international on-site inspections, such as activities by the United Nations Special Commission (UNSCOM) in Iraq, may confirm allegations. Even so, the certainty of a programme or a stockpile does not necessarily reveal anything about capability (which, in turn, depends on the definition of capability).[1] For example, the Japanese cult Aum Shinrikyo, which was responsible for the 1995 nerve agent attack in Tokyo, was developing biological agents for terrorist use, but never achieved the capability to disseminate them on a large scale.

This paper presents a brief history of BW proliferation and an overview of the current proliferation assessments. Three cases are described in more detail: Russia, Iraq and the proliferation threat of sub-state actors. Each case study is followed by a discussion of the impact on the BTWC and how the future protocol might resolve the issue. The final section deals with one of the greatest challenges to the future BTWC regime: the massive transfer of civilian technology to military applications in the case of a serious security crisis.

A historical overview

Several references to early forms of biological warfare exist, such as dipping arrows in putrefied flesh, infecting wells with decomposing corpses, catapulting cadavers over town walls or giving infected blankets from hospitals to indigenous tribe members. Biological warfare in its current understanding began in the First World War. Germany attempted sabotage with pathogens against livestock in the United States destined for Europe and the Middle East and considered similar acts in Central Europe. A better understanding of disease transmission in the 1920s and 1930s and the dramatic experiences of the Spanish Flu epidemic at the end of the First World War increased concerns about biological warfare. Based on essentially faulty intelligence about the intentions of other states and fears of vulnerability, several countries began to look seriously at the feasibility of biological warfare. Germany's research and development remained splintered throughout the Second World War and did not lead to a useful weapon. More concerted efforts in Canada, the United Kingdom and the United States led to the three countries pooling their resources in the early 1940s. Despite huge investments of resources, the Allies failed to produce an operational offensive biological weapon, apart from a limited British capability to retaliate with anthrax against German cattle. Japan's biological weapon programme began in the early 1930s and lasted until the end of the war. Yet, despite the human experiments and the tests during military operations in China and against Soviet troops, the Japanese had made no more progress than the Allies, as the United States learned after granting the head of the BW programme immunity from prosecution for war crimes.[2]

While post-war research and production of offensive BW continued in the Soviet Union and the United States, most secondary powers gradually abandoned their offensive BW programmes to formally concentrate on defence, protection and prophylaxis. Until the end of the Cold War few countries other than those that had begun BW-related investigations during the inter-war years were known to have started new biological warfare programmes. However, several of these countries are located in the highly volatile Middle East. The BTWC reflected the belief expressed by American President Richard Nixon in 1969 that BW are of very limited military value.

A major anthrax outbreak near Sverdlovsk (now Yekaterinburg) in 1979 as a consequence of an accidental release from a nearby military laboratory suggested that the Soviet Union, despite being a co-depository of the BTWC, was continuing an offensive BW programme. Persistent American allegations during the 1980s that Soviet troops in Afghanistan and Soviet proxies in South-East Asia were waging biological warfare exposed the intrinsic weaknesses of the BTWC and raised concerns about BW proliferation. Subsequently, several countries began to be identified as BW proliferators.

It nevertheless came as a major shock in the 1990s when the international community learned of the extent of Iraq's offensive BW programme. Moreover, the elaborate efforts to conceal its BW programme from UNSCOM inspectors and the willingness to endure international sanctions and military punishment testify to the importance the Iraqi leadership attaches to BW.

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The investigations into the activities of Aum Shinrikyo uncovered the cult's interest in biological warfare agents. Although it never managed to produce a viable agent, the discovery fuelled the fear of sub-state proliferation and biological terrorism.

Today's concerns

The United States is the main source of public information on proliferation developments. In 1997, American proliferation analyses converged on a figure of 'at least twenty countries' that 'already have or may be developing nuclear, biological, or chemical weapons, or their missile delivery systems'.[3] The next year, however, the figure had risen to twenty-five.[4] According to the Russian Federation Foreign Intelligence Service (Sluzhba Vneshney Razvedki, SVR) twenty-five countries, many of which are found close to Russia's borders, have or are developing various types of non-conventional weaponry.[5] As these figures comprise four categories of weaponry, isolating the BW threat assessment is impossible. In the only known statement in 1998 by an American government official in which the figure did not encompass nuclear weapons, Deputy Secretary of Defense, John J. Hamre noted that 'At least two dozen nations already possess chemical and biological weapons or have active development programs to build them.'[6]

In 1997 the American Department of Defense listed seven countries as having a BW programme in various stages of development in its proliferation report: China, India, Iran, Iraq, North Korea, Pakistan and Russia.[7] Libya was said to lack the scientific and technical base for a BW programme. Syria was believed to possess the biotechnical infrastructure to support a BW programme. However, compared to an earlier assessment four countries were conspicuously absent, namely, Egypt, Israel, Taiwan and South Korea.[8] In 1999 the American Central Intelligence Agency (CIA) and the Arms Control and Disarmament Agency (ACDA) claimed that up to twelve countries are pursuing offensive BW programmes. The following states are said to have an offensive BW capability or are in the process of seeking such a capability: China, Egypt, Iran, Iraq, Libya, Russia and Syria. North Korea may be able to wage biological warfare, Sudan may be interested in BW, and there is insufficient evidence to determine whether Taiwan is developing activities prohibited under the BTWC.[9]

The variations in the lists indicate the uncertainties involved in naming suspected BW proliferators. Determining the status of the BW programme for an individual proliferant state is even more complicated for an outside analyst: the descriptions range from 'possessing the biotechnical infrastructure', 'various stages of development' and 'in the process of seeking such a capability' to having 'an offensive BW capability'. Once the future protocol to the BTWC will have entered into force it will be an important task to resolve these uncertainties and allegations. However, it will be equally important to publish the core information regarding the past and present compliance with the BTWC regime in order to generate confidence among the state parties. Excessive secrecy, as is currently the practice with the 1993 Chemical Weapons Convention (CWC), may actually undermine the value of the BTWC as a security regime as wild proliferation allegations go unchallenged.

The next three sections deal with concrete cases of proliferation, namely Russia, Iraq and sub-state proliferation, and discuss how they may affect the future BTWC regime.

Continuing concerns about Russia

Doubts about the termination of Russia's BW programme, as decreed by then President Boris Yeltsin in April 1992, persist. Factors that may contribute to a continuation of the offensive BW programme include institutional and bureaucratic interests, the enduring social and economic crisis, a further deterioration of relations with the West and with Russia's neighbours, a continuing focus on the reestablishment of Russia's status as a superpower, and the prospect of an inefficient protocol to the BTWC.[10]

The dire social and professional conditions in which the former Russian BW specialists currently live significantly increase the risk of a 'brain drain' to countries that may be interested in acquiring BW. Since Yeltsin's 1992 decree the BW-related establishments have laid off large numbers of personnel, while the remaining staff work under spartan conditions and often go without pay for long periods.[11] The feared mass exodus of BW scientists and technicians does not appear to have materialized, although some BW specialists are known to have sought contracts abroad.[12] Russia has nevertheless tried to prevent proliferation with new legislation. In January 1998 then Prime Minister Viktor Chernomyrdin issued a directive which prohibits Russians from engaging in foreign economic activities concerning goods and services potentially applicable for nuclear, biological and chemical (NBC) weapons or missile delivery systems.[13] In May 1998 the Russian Federal Currency and Export Control Service issued a procedural explanation of the functioning of the export control system created by the federal directive. Today, President Putin may be prepared to bring Russia within full compliance of the BTWC and allow a greater degree of transparency regarding activities of relevance to the convention. This may be a part of a broader strategy to harness international support for his arms control objectives — especially regarding nuclear weapons and ballistic missile defences — and secure the non-interference in Russia's internal conflicts.

Through the Comprehensive Threat Reduction (CTR) programme the United States attempts to defuse the BW threat from the former Soviet Union. The former Soviet BW facility in Stepnogorsk, Kazakhstan, is being dismantled with American assistance. It was used to produce weapons for an offensive biological warfare programme, including production of resistant strains of anthrax.[14] Work was expected to be completed by July 2000, but is still continuing at the time of writing.[15]

Originally primarily designed to eliminate Soviet and American chemical weapons (CW), the CWC—now in its fourth year of operation — has developed into a remarkably co-operative regime. The Technical Secretariat of the Organisation for the Prohibition of Chemical Weapons (OPCW) is helping states parties to be in the fullest possible compliance. Regional fora and bilateral interaction support this co-operative approach. There is an important lesson to be learned for the future BTWC protocol, whose verification requirements are still being defined by Cold War standards. Allowing for a broader scope of co-operation — bilateral, regional, or via the envisaged organization for the prohibition of BW — may be the most effective remedy against future proliferation. The multiple interactions on the level of governments, institutes and individuals — in addition to the more traditional verification and monitoring mechanisms — will enhance transparency regarding relevant activities. Russia's participation in the CWC has led to a growing number of industrialized states offering financial and technical assistance for the destruction of its CW stockpile. The conclusion of the protocol to the BTWC and Russia's early participation may stimulate similar assistance and thereby reduce the potential for proliferation from Russia significantly. Similar assistance programmes should be offered to other states (of concern) as an incentive to join the protocol (and the BTWC, if need be).

The Iraqi conundrum

After the 1991 Gulf War the United Nations Security Council adopted Resolution 687 on 3 April 1991, which among other things created UNSCOM. This body had two basic functions: to inspect and oversee the destruction or elimination of Iraq's CBW and ballistic missile capabilities; and to monitor Iraq over the longer term to ensure its continued compliance with the obligations of Resolution 687.[16] In 1999 UNSCOM was disbanded following a period in which Iraq systematically obstructed UNSCOM inspections and exploited the political disagreement among the permanent members of the UN Security Council to its advantage. On 17 December 1999 the Security Council adopted Resolution 1284 which replaced UNSCOM with the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC). At the time of writing (July 2000) UNMOVIC has not yet been able to carry out any of its tasks inside Iraq and even when it will be allowed to enter the country it remains uncertain whether UNMOVIC will be more successful than UNSCOM.

The accounting of Iraq's BW-related activities remains incomplete. Within its first year of operations UNSCOM found evidence that Iraq's initial declarations about a small BW research programme were incorrect and incomplete. It continued to uncover details, but it was not until Iraq was forced to admit that it had an offensive BW programme, which included the production of biological warfare agents, in July 1995 and the defection of Lieutenant General Hussein Kamal the next month that the extent of the Iraqi BW programme was fully appreciated. The Iraqi concealment efforts nonetheless continued. In 1998 further evidence was found that Iraq had weaponized biological warfare agents, including the filling of warheads for the Scud ballistic missile. Table 1 summarizes Iraq's BW declarations and UNSCOM's findings and estimates of weaponry and equipment unaccounted for based on UNSCOM's January 1999 report.[17]

The UNSCOM experience has revealed two troubling issues with respect to the future BTWC regime. First, the UN Security Council has so far been unable or unwilling to deal with Iraq's systematic violations of its own resolutions because some members succumbed to short-term interests. As few cases will be as clear-cut as that of Iraq, this raises serious doubts about the ability or willingness of the UN Security Council to uphold fundamental norms in the name of the international community when confronted by a determined and persistent violator. For major disarmament treaties, such as the BTWC and CWC, the Security Council is the ultimate arbiter in the case of material breaches.

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Second, under UN Security Council Resolution 687 Iraq was forced to become a state party to the BTWC. States normally voluntarily engage in an international agreement and the legal consequences of this move have not yet been the subject of much learned debate. Nevertheless, since 1991 one state party is in continuous material breach of the BTWC. This material breach does not concern as much the presence of a BW programme before the Gulf War (which under the 1969 Vienna Convention on the Law of Treaties Iraq should not have had as a signatory state to the BTWC), as it does Iraq's persistent concealment efforts and the concomitant refusal to destroy all its BW and related installations and equipment after becoming a full party to the BTWC. None of the other states parties have taken up this condition in order to restore treaty compliance under Article VI of the BTWC (which allows a state party to lodge a complaint with the UN Security Council) or

Table 1.

	Declarations by Iraq		UNSCOM findings[1]
Type of weapon or equipment	Amounts declared in FFCDs	Material balances	Assessment of Iraqi declarations
Al-Hussein missile warheads (BW) Warhead fillings:[2] - Botulinum toxin - Anthrax spores - Aflatoxin	25 16 5 4	All destroyed unilaterally.	Not supported by conclusive evidence; analysis of samples from excavated remnants of warhead containers does not support the FFCDs; the locations of these remnants are inconsistent with the FFCDs; consequently, there are major doubts about the accounts of weapon fillings, deployment and subsequent destruction.
R-400 aerial bombs (BW) Bomb fillings: - Botulinum toxin - Anthrax spores - Aflatoxin	200 100 50 7	157 filled and 43 unfilled bombs were destroyed unilaterally.	The R-400 declaration was changed several times; the account in the 1997 FFCD was both incomplete and inaccurate according to review by international experts; only partial verification of the destruction of the bombs.
Aircraft drop tanks (Iraq was also developing a pilotless aircraft to carry the drop tank.)	4	1 destroyed in the 1991 air campaign; 3 destroyed unilaterally by Iraq.	No validation of data in Iraq's declarations; 12 more drop tanks may have been modified for BW use; verification of destruction of 3 drop tanks by Iraq; there is no physical evidence to support Iraq's claim that 1 drop tank was destroyed in the war.
Aerosol generators	The June 1996 FFCD includes a description of the devices, but does not state the number produced. The production of 12 aerosol generators was acknowledged in interviews with Iraqi personnel.	No Iraqi declaration about disposal.	The generators have not been accounted for.
Mobile storage tanks for agents	47	Unknown number destroyed; no specification whether unilaterally or in Gulf War.	Remnants of approximately 22 destroyed tanks have been turned over to UNSCOM; the remnants of 2 other tanks have been found; the rest remains unaccounted for.
Bulk Botulinum toxin[3]	19,180 litres	10,820 litres were filled in missile warheads and bombs; 499–569 litres were used in field trials; 118 litres were wasted during handling; 7,665–7,735 litres were destroyed unilaterally.	Iraq's statements are unsupported; inability to verify the amount of Botulinum toxin produced; inability to verify Iraq's material balance.
Bulk Anthrax spores	8,445 litres[4]	4,975 litres were filled in missile warheads and bombs; 52.5 litres were wasted during handling; 3,412 litres were destroyed unilaterally.	The statements in the 1997 FFCD are unsupported; inability to verify the amount of Anthrax produced; inability to verify Iraq's material balance.

Bulk Aflatoxin	2,200 litres	1,120 litres were filled in missile warheads and bombs; 231–301 were used in field trials; 30.5 litres were wasted during handling; 900–970 litres were destroyed unilaterally.	The statements in the 1997 FFCD are unsupported; inability to verify the amount of Aflatoxin produced; inability to verify Iraq's material balance.
Bulk *Clostridium perfringens*	340 litres	338 litres were destroyed unilaterally.	Neither figure could be verified.
Bulk Ricin	10 litres (produced from 100kg of castor beans)	All used in field trials.	Neither figure could be verified.
Bulk Wheat cover smut	Not quantifiable	All unilaterally destroyed.	Neither declaration could be verified.
Growth media			General inability to verify the figures.[5]
Casein	17,554kg	7,074kg were used in botulinum toxin production; 145kg were lost or wasted; 10,335kg were destroyed under UNSCOM supervision.	Minimum of 460kg unaccounted for based on UNSCOM importation data.
Thioglycollate broth	6,036kg	4,130kg were used in botulinum toxin production. 58 kg were lost or wasted. 1,848 kg were destroyed under UNSCOM supervision.	Minimum of 80kg unaccounted for based on UNSCOM importation data.
Yeast extract	7,070kg	1,964 kg were used in botulinum toxin, anthrax and *clostridium perfringens* production; 15kg were lost or wasted; 4,942kg were destroyed under UNSCOM supervision.	Minimum of 520kg unaccounted for based on UNSCOM importation data.
Peptone	1,500kg	45kg were used in *clostridium perfringens* production; 705kg were lost or wasted; 625kg were destroyed under UNSCOM supervision.	Minimum of 1,100kg unaccounted for based on UNSCOM importation data.

FFCD Full, Final and Complete Disclosure

1. All declarations by Iraq in the FFCDs were repeatedly rejected by UNSCOM and several panels of international experts (September 1997, March 1998 and July 1998).
2. Iraq changed its declaration in a statement to UNSCOM in July 1998: Botulinum toxin: 5; Anthrax spores: 16; and Aflatoxin: 4. UNSCOM Report, UN doc. S/1999/94 of 29 January 1999, Appendix 3, section 'Al-Hussein missile warheads'.
3. UNSCOM data only gave the volume of bulk agents, but not the concentration of the agent in the mix. It is therefore impossible to give the approximate weight of the biological warfare agents.
4. Based on statements by Iraqi officials, UNSCOM inspectors calculated the following conversion equation for the anthrax bombs: 100 litres of filling equals 140kg (density = ±1.4), containing 1.2% of dried Anthrax spores. Per 100 litres there would thus be 1.68kg of agent. T. Trevan, *Saddam's Secrets: The Hunt for Iraq's Hidden Weapons,* London, Harper Collins, 1999, p. 318. Based on this equation Iraq may have produced approximately 141.9kg of anthrax spores.
5. Iraq did not report all the growth media UNSCOM knows it has imported. The figures on growth media used in the production of biological warfare agents are derived from estimates of how much agent was produced. According to the January 1999 UNSCOM report, these figures are the result of a theoretical calculation and have little supporting evidence. There are also substantial uncertainties about the amounts declared as lost or wasted.

through the procedure of convening a formal consultative meeting of states parties under Article V.[18] They probably felt that the UN Security Council was already addressing the issue through UNSCOM. However, UNSCOM had in effect become inoperational since the summer of 1998 and formally ceased to exist in December 1999. The fact that Iraq remains in material breach of the BTWC has still not been formally addressed in the context of the BTWC.

Sub-state proliferation threats

In 1994 and 1995 the Japanese religious cult Aum Shinrikyo carried out two attacks with the nerve agent sarin. Police investigations into the cult's activities showed that it had also been investigating pathogens and toxins and had attempted several times to release them, apparently with no effect. As a consequence of these events, the threat projections of terrorism with CBW were no longer hypothetical scenarios. Since then most studies have focussed on the potential consequences of such future attacks: relatively small amounts of chemical or biological warfare agents are claimed to be able to produce huge numbers of casualties — according to some estimates, hundreds of thousands. However, the reasons why the Aum Shinrikyo sarin attacks produced relatively few casualties, why the cult was unable to produce a viable biological warfare agent or why such events did not occur earlier are currently not or only unsatisfactorily explained.

Theoretically, some military-grade agents can produce large numbers of fatalities and casualties. The processes for manufacturing and disseminating the most lethal and complex biological warfare agents in sufficient quantities to obtain such effects are nonetheless complex. Despite large investments, Aum Shinrikyo's BW programme experienced considerable problems. Three factors in particular contributed to this outcome. First, the people in charge of the programme may have been bright and skilled university graduates, but the support staff in the laboratories consisted of unskilled cult members who had been selected on the basis of their loyalty in order to reduce the risk of information leaks. Their inexperience negatively affected the quality of the research and development. Second, the cult lacked functional specialization: the people responsible for the research on the pathogens and toxins were also responsible for designing the laboratories and dissemination devices and were in charge of the agent production, the preparation and execution of the terrorist operations in Tokyo, and so on. No single person can combine all these qualifications. Third, the programme was dependent on external sources of supply, and it had to be conducted in secrecy because, unlike a state seeking BW, a terrorist organization does not enjoy freedom from prosecution. These factors, taken together, considerably complicate the acquisition of such weaponry.[19]

A scenario published in the SIPRI Yearbook 2000 describes how a cult disseminates anthrax over a busy shopping centre. The agent is of a type and quantity similar to that which was accidentally released from a military microbiology facility in Sverdlovsk in 1979.[20] Given realistic conditions, about 20–30,000 persons could be exposed to the cloud of spores. However, only around 300 people concentrated in a relatively narrow area would be infected but not necessarily killed. This contrasts with the many predictions that such use would result in mass casualties over large areas.[21] In reality, such an incident would nevertheless place a heavy burden on the authorities in terms of medical response and decontamination. Yet, if they were prepared to treat the approximately 30,000 exposed people with antibiotics within a few days after the incident the consequences would be limited. Without any medical treatment most of the 300 infected people would die. Different environmental conditions (e.g., in a large sports stadium an estimated 1,500 out of 30,000 people present would acquire an infective dose) or the choice of a highly contagious agent would place different strains on the response services.

Governments face a multitude of biological terrorism threats, but the most catastrophic scenarios involving mass casualties, though possible, are not likely to occur. (Catastrophic scenarios involving non-conventional weapons, which feature in many policy debates, are often made plausible by insistence on the existence of a threat posed by state-sponsored terrorism.) Nevertheless, because of the potential consequences for the targeted society of a terrorist attack with BW, governments must be prepared for such an attack. The key issue is thus to devise and execute balanced policies. Overreaction can lead to countrywide anxiety and paranoia. In such an atmosphere, hoaxes may become as efficient — especially in terms of economic terrorism — as actual attacks with BW.

The future protocol can assist in preventing and deterring terrorism with BW by requiring states parties to adopt penal legislation affecting all stages of the BW armament process. It can also explicitly offer emergency assistance in case a state party becomes the victim of such an attack (the CWC does not include a specific provision to this effect because the Japanese sarin attacks occurred after the conclusion of the negotiation, but it is widely accepted that a state party can request the OPCW for assistance in such an event). Measures enabling states parties to upgrade their domestic response capabilities if they so desire could also be included in the future protocol as an additional incentive to join.

Future concerns

Proliferation studies principally focus on the transfer patterns of tangible objects, such as agents and equipment, and the threat of the immediate realization of the dual-use potential of these objects, whereby certain countries (or sub-state actors) of concern acquire technology developed for civilian use and instantly apply it for the purpose of acquiring BW. Yet, at the core of the biotechnological revolution is information: data collection and processing, knowledge, techniques and skills. Moreover, biotechnology produces enabling technologies for many civilian applications that contribute to future information accumulation and product and process improvements. This information core not only permeates the society in which the development takes place: today's globalization and growing interdependence inevitably entail its diffusion across national borders. While lateral proliferation processes are undeniably taking place, the greatest challenge to the future BTWC regime may actually come from a sudden massive application of civilian biotechnology for the purpose of acquiring a biological warfare capability within a state party.

The following scenario assumes that the implementation of the protocol to the BTWC is successful. As a result, confidence in the assumption that biotechnology works for the greatest benefit of mankind is growing while concerns about the realization of the dual-use potential are receding. However, after several decades a major crisis (food or water shortage, migratory pressure, and so on) erupts and leads to an armed conflict between two or more states. A military victory is elusive and one of the warring parties decides to use off-the-shelf biotechnology for the manufacture of biological warfare agents and its antidotes at short notice. Decades of process and product improvements in the civilian sector have provided scientists, engineers and technicians with the skills to meet this demand at short notice: a pathogen is slightly modified to overcome enemy defences and the engineered antidote is produced on a large scale to protect the own troops and population. The ravaging disease decimates the enemy; its society collapses and the victor has new space and resources for its expanding population. There was never any time to respond to the unfolding crisis under the BTWC and its protocol before the end of the war. A successful security regime of many decades crumbles within a matter of weeks.

This pessimistic scenario is not without precedent. More than 100 years ago advances in chemistry, together with an increasingly utilitarian application of scientific principles driven by an economic rationale, was propelling the second industrial revolution in West Europe and the United States. Most of the chemical compounds that were eventually used as warfare agents in the First World War had been discovered many decades earlier and some played an important role in the then rapidly expanding chemical industry. For example, chlorine, the main agent in the German CW attack near Ypres on 22 April 1915, was first prepared in 1774.[22] Phosgene, the prime killer agent of the First World War, was discovered in 1811.[23] The skin blisters and symptoms of conjunctivitis typical of exposure to mustard gas were already described in a two-part study on olefines published in 1860–1861.[24] No one was actively considering the exploitation of the toxic properties of these new compounds in combat. However, there was a rising concern about the ability to mobilize the rapidly expanding industrial capacity in support of a future war effort. Russia, then a primarily agrarian society, sought to restrain the impact of technology and industrialization on future war fighting capabilities and the resulting 1899 Hague Peace Conference produced, among other key documents, the Declaration (IV, 2) Concerning Asphyxiating Gases. The contracting powers agreed to abstain from the use of projectiles whose object is the diffusion of asphyxiating or deleterious gases. However, the declaration could not withstand military necessity. By the late autumn of 1914, Germany's lightning war in Belgium and France had bogged down in trench warfare and a frantic search began to find a technology that could restore the offensive. Toxic chemicals were one of the first and almost immediately available solutions. In April 1915 Germany circumvented the declaration by releasing the gas from cylinders, but by the time gas projectiles were introduced, the document had become all but irrelevant.

The types of international agreement in the hypothetical scenario and the historical example differ significantly. However, in both cases military necessity pushes a technology transfer from civilian to military application, thereby ignoring international law. Chemical warfare contributed significantly to the integration of science, military and industry, so that the military potential of civilian applications is now immediately recognized. The exploration of potential spin-off effects of civil-led technology developments for military purposes has almost become standard practice in order to reduce the cost of weapon systems or to achieve shorter cycles of technological innovation. Going against this trend, the BTWC seeks to exclude the potential military exploitation of civilian biotechnology developments. Yet this goal cannot be fully achieved because the permitted development of the means to defend against BW is inescapably linked to the possession of knowledge about current and potential biological warfare agents.

If the protocol to the BTWC is to remain relevant for many decades to come, it will require new mechanisms to deal with the instant realization of the dual-use potential of biotechnology within a state party. In addition to the traditional verification and monitoring of the destruction and non-production of BW in states parties, it must incorporate an understanding of biotechnology and technology transfer processes that goes beyond mere products (agents, production equipment, etc.). The aim of this new set of tools is to render transparent technology transfers between economic units within a state party and between economic units across national boundaries. All economic units — states, companies and institutes, or individuals — involved in a transaction will share the responsibility of ensuring that the dual-use potential of the technologies is not realized. The explicit commitment by the economic unit, whether a supplier or a recipient, to uphold this responsibility will then become a key component for granting the transfer license. The principle also applies to scientific and student exchanges as in-depth background knowledge will enhance the transparency about the institute's and the individual's

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activities. The national authorities and the international organization to be set up under the protocol will monitor the transparency of all relevant technology transfers. This mechanism of shared responsibilities between suppliers and recipients can facilitate assistance to countries such as Russia as confidence in the compliance with the BTWC will grow, while making it much harder for future Iraqs or representatives of terrorist organizations to acquire the BW-relevant technologies.

This set of tools must nonetheless be supplemented with extensive positive security guarantees in order to reduce the disproportionate military advantage a state party might gain from defecting from the treaty. These guarantees do not solely entail the right of access to assistance and protection (subject to the transparency conditions mentioned above), but also involve dynamic decision-making procedures in order to be able to respond swiftly and decisively in the case of a rapidly developing crisis. If adequately implemented, the mechanisms to enhance the transparency of technology transfers may be able to provide sufficient advance warning of an impending massive transfer of civilian technology for prohibited purposes.

Notes

1 See, for example, Julian P. Perry Robinson, 'Chemical weapons proliferation: security risks', in Jean Pascal Zanders and Eric Remacle, eds., *Chemical Weapons Proliferation: Policy Issues Pending an International Treaty*, Proceedings of the 2nd Annual Conference on Chemical Warfare, Vrije Universiteit Brussel, 16 March 1990 (Centrum voor Polemologie, Vrije Universiteit Brussel, Brussels, 1991, pp. 69–92.

2 The BW programmes of several countries are analyzed in Erhard Geissler and John Ellis van Courtland Moon, eds., *Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945*, SIPRI Chemical & Biological Warfare Studies, no. 18, Oxford, Oxford University Press, 1999, 279p.

3 Counterproliferation Program Review Committee, *Counterproliferation: Chemical Biological Defense*, CPRC Annual Report to Congress (1997), chapter 3. http://www.acq.osd.mil/cp/cprc97.htm

4 *Current and Projected National Security Threats to the United States*, Hearing before the Select Committee on Intelligence, United States Senate, 105th Congress, Second session, Washington, DC, Government Printing Office, 1998, p. 9.

5 Maj. Gen. V.S. Belous and A.I. Podberezkin, 'There is no alternative to chemical disarmament', Nezavisimoye Voyennoye Obozreniye (Moscow), 4–10 June 1999, p. 4, in 'Chemical weapons disarmament viewed', Foreign Broadcast Information Service, *Daily Report–Central Eurasia (FBIS-SOV),* FBIS-SOV-1999-0626, 30 June 1999.

6 Remarks to the NATO Workshop in Vienna on 22 June 1998, as reproduced in US Department of Defense, 'Hamre: Counterproliferation efforts must include defense against cyberattacks, WMD', *Defense Viewpoint*, vol. 13, no. 44. http://www.defenselink.mil/speeches/1998/s19980622-depsecdef.html

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[11] Amy E. Smithson, *Toxic Archipelago: Preventing Proliferation from the Former Soviet Chemical and Biological Weapons Complexes*, Report no. 32, Washington, DC, Henry L. Stimson Center, December 1999, p. 16.
[12] Tucker, op. cit., p. 6.
[13] 'Russia: stricter export controls imposed on goods usable in arms production', Russian Federation Government Directive no. 57 (22 January 1998), *Rossiyskaya Gazeta* (Moscow), 18 February 1998, p. 1 in 'Russia: Chernomyrdin decree on dual-use goods export controls', FBIS-TAC-98-048, 21 February 1998.
[14] '30 June', *CBW Conventions Bulletin*, no. 41, September 1998, p. 33.
[15] Comprehensive Threat Reduction Programme, 'CTR – Kazakhstan: Biological Weapons Production Facility Dismantlement', http://www.dtra.mil/ctr/projects/projkaz/kpj-bwp.html, version current 3 September 2000.
[16] The task of inspecting, destroying and removing all of Iraq's nuclear weapon capabilities was assigned to the International Atomic Energy Agency (IAEA). UNSCOM's mandate also included to assist and co-operate with the IAEA in its work in Iraq.
[17] The table was prepared by Maria Wahlberg, SIPRI CBW Project.
[18] The procedure was adopted at the Third Review Conference of the BTWC in 1991. *Final Document of the Third Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction*, Part II, Final Declaration, document BWC/CONF.III/22, 27 September 1991, Article V. It was invoked by Cuba on 30 June 1997 in order to investigate an alleged American attack with biological warfare agents in October 1996.
[19] For more detailed analysis, see Jean Pascal Zanders, 'Assessing the risk of chemical and biological weapons proliferation to terrorists', *Nonproliferation Review*, vol. 6, no. 4 (Fall 1999), pp. 17–34; Jean Pascal Zanders, Edvard Karlsson, Lena Melin, Erik Näslund and Lennart Thaning, 'Risk assessment of terrorism with chemical and biological weapons', *SIPRI Yearbook 2000: Armaments, Disarmament and International Security,* Oxford, Oxford University Press, 2000, pp. 537–58.
[20] *Ibid,* pp. 549–54. The computer simulation was prepared and run by the Swedish National Defence Research Establishment (FOA), Umeå, Sweden. In the Sverdlovsk incident an estimated 4 billion respirable spores became airborne and approximately sixty-five people died.
[21] In order to generate 4 billion respirable anthrax spores, a total of approximately 80 billion would have to be released. Such an amount can easily be suspended in a few litres of solution. With optimal distribution and inhalation this number could infect approximately 4–5 million people (the infective dose is assumed to be 8,000–10,000 inhaled spores). However, this estimate is of limited value since only a small fraction of the released spores would reach people because of the dispersion in the atmosphere. An even smaller fraction of the amount would be respirable. *Ibid*., p. 550.
[22] J. Meyer, *Der Gaskampf und die chemischen Kampfstoffe* [Chemical warfare and chemical warfare agents], Leipzig, Verlag von S. Hirzel, 1925, p. 308.
[23] T.A. Ryan, C. Ryan, E.A. Seddon and K.R. Seddon, *Phosgene and Related Carbonyl Halides,* Amsterdam, Elsevier, 1996, pp. 4–12.
[24] F. Guthrie, 'On Some Derivatives from the Olefines', *Quarterly Journal Chemical Society*, vol. 12, pp. 109–20; and F. Guthrie, 'On Some Derivatives from the Olefines', *Quarterly Journal Chemical Society*, Vol. 13, pp. 129–35.