

*The Proliferation of Chemical and Biological Weapons Materials  
and Technologies to State and Sub-State Actors*

**Testimony by  
Jonathan B. Tucker, Ph.D.  
Director, Chemical & Biological Nonproliferation Program  
Center for Nonproliferation Studies  
Monterey Institute of International Studies  
Washington, D.C. Office**

before the  
Subcommittee on International Security,  
Proliferation, and Federal Services  
of the  
U.S. Senate Committee on Governmental Affairs

November 7, 2001, 2:30 p.m.  
Room 342, Dirksen Senate Office Building  
Washington, D.C.

Mr. Chairman, distinguished Members of the Subcommittee, and guests:

Many thanks for the opportunity to appear before you this afternoon on a topic of great importance and concern in the aftermath of September 11: the proliferation of chemical and biological weapons to states and terrorist organizations.<sup>[1]</sup> The recent series of anthrax attacks through the U.S. mail indicates that the global spread of dual-use technologies, materials, and scientific know-how relevant to the production and delivery of chemical and biological weapons (CBW) poses a serious threat to U.S. national security. Although to date the exposures to anthrax-tainted letters have remained limited, a large-scale attack with a chemical or biological agent against U.S. targets at home or abroad is a real possibility.

In the past, only a few terrorist groups have acquired and used unconventional weapons, and nearly all have encountered major technical hurdles in doing so. Nevertheless, the anthrax attacks against the United States indicate that terrorist use of biological weapons is no longer theoretical; bioterrorism is a clear and present danger. The anthrax mailed to Senator Tom Daschle's office contained dried spores that had been milled to an extremely fine powder and processed with chemical additives so that they would become readily airborne and infect through the lungs, suggesting that the perpetrators had access to specialized military technology and know-how related to the "weaponization" of anthrax. Perhaps they acquired a limited supply of this material on the international black market, or—more worrisome—developed a manufacturing capability for dried anthrax powder. If the latter is true, the perpetrators would have the potential to disseminate larger quantities of dried anthrax spores through the air, potentially exposing thousands of people.

Although the recent attacks have been relatively small-scale and not designed to inflict mass casualties, their dramatic psychological and economic impact on American society may inspire further biological weapons proliferation by rogue states and terrorists. Moreover, in a unipolar world in which U.S. conventional military might predominates, it is increasingly likely that rogue states will turn to chemical

and biological weapons as a force equalizer or means of “asymmetric” warfare.

Given the possibility that the perpetrators have received assistance from former weapons scientists or from a state-sponsor, it is important to assess: (1) which states possess chemical and biological weapons, and (2) the extent to which trade in dual-use materials and technologies contributes to clandestine chemical and biological weapons (CBW) programs. My testimony will first discuss the state and sub-state actors of CBW proliferation concern. I will then turn to technologies and materials that could be employed to produce and deliver these agents.

### *States of CBW Proliferation Concern*

Evidence from open sources indicates that roughly 13 countries are actively seeking biological weapons and closer to 20 are pursuing chemical warfare capabilities. Proliferant states of particular concern to the United States include Iraq, Iran, Libya, North Korea, Sudan, and Syria.

### *Iraq*

The precise status of Iraq’s chemical and biological weapons programs is unknown because of that country’s efforts since 1991 to conceal the full extent of its prohibited activities. Iraq’s expulsion of inspectors from the United Nations Special Commission (UNSCOM) in December 1998, and its continuing refusal to admit inspectors from the successor agency, the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC), has further impeded international efforts to assess the status of Iraq’s prohibited weapons programs. It appears likely, however, that Iraq has rebuilt key elements of its chemical and pharmaceutical production infrastructure that were destroyed during the Gulf War and by UNSCOM. These dual-use facilities could easily be converted to the production of CBW agents, and probably already have been.

Various reports indicate that Iraq may retain a sizable stockpile of chemical munitions, including 25 or more special chemical/biological warheads for the al-Hussein ballistic missile and 2,000 aerial bombs. Iraq is also believed to possess sufficient precursor chemicals to produce hundreds of tons of mustard gas, VX, and other nerve agents.<sup>[2]</sup> In short, Iraq retains the materials and technical expertise to revive its chemical warfare program within months, if it has not already done so. Iraq has not signed or the Chemical Weapons Convention.

Iraq is also believed to retain a substantial offensive biological warfare (BW) capability. During the UNSCOM inspections, Iraqi officials repeatedly misled the inspectors as to the nature and extent of its BW program and prevented them from verifying its claim to have unilaterally destroyed its biological arsenal. According to some estimates, Iraq may retain a stockpile of BW munitions, including more than 150 R-400 aerial bombs and 25 or more special warheads for the al-Hussein ballistic missile. Iraq may also have retained a mobile production facility with the capacity to produce dried biological agents, which are particularly lethal. Iraq has not accounted for 17 metric tons of bacterial growth media and may possess undeclared stocks of smallpox virus. Iraq currently maintains the technical expertise and equipment to reconstitute its biological warfare capabilities within months, including production of anthrax bacteria, botulinum toxin, aflatoxin, and *Clostridium perfringens* (gas gangrene) toxin.<sup>[3]</sup>

### *Iran*

Although Iran has signed and ratified both the Chemical Weapons Convention and the Biological Weapons Convention, it continues to pursue the acquisition of technologies and materials needed for the production of chemical and biological agents. Iran began its chemical weapons program in the mid-1980s in response to Iraqi chemical attacks during the Iran-Iraq War. After 1985, Iran began manufacturing and

stockpiling blister, blood, and choking agents, including cyanogen chloride, phosgene, and mustard gas. Reportedly, Iran began nerve agent production in 1994. Iran continues to augment its chemical weapons production capability by seeking to acquire relevant production technology, technical expertise, and precursor chemicals from other states, including Russia and China.[\[4\]](#)

Iran appears to have initiated a biological weapons-related research program in the 1980s. It is possible that Iran has produced small quantities of agents and has begun to weaponize them, although the types of pathogens produced are unknown. Iran is suspected of having a BW research laboratory at Damghan. Furthermore, Iran has attempted to purchase BW-related materials from foreign sources, ostensibly for civilian use.[\[5\]](#) Given the dual-use nature of many of the pathogens, materials, and equipment used in the pharmaceutical and biotechnology industries and in biomedical research, it is difficult to ascertain the extent to which Iran is engaging in legitimate or illicit activity.

### *Libya*

During the 1980s, Libya produced more than 100 metric tons of nerve and blister agents at the Rabta facility, which Libya claimed was a pharmaceutical plant. A project to build a large underground chemical and biological weapons production facility at a second site called Tarhunah has been underway since 1995, although international pressure has slowed the pace of construction. Libya has not signed the Chemical Weapons Convention and is heavily dependent on foreign suppliers for precursor chemicals and production equipment.[\[6\]](#) The Libyan CW plant at Rabta was designed by the German firm Imhausen-Chemie and production equipment was supplied by other West European and Japanese companies.[\[7\]](#)

Libya's biological weapons program has apparently not advanced beyond the research and development stage. It is possible, however, that Libya can produce small quantities of BW agents. Libya's offensive BW program is heavily dependent on dual-use materials and foreign assistance.[\[8\]](#)

### North Korea

Evidence in the public domain suggests that North Korea has operated an extensive CW program for many years and has the ability to produce a variety of agents, including adamsite, mustard, sarin, and VX. North Korea has not signed the Chemical Weapons Convention.[\[9\]](#)

Although North Korea is a party to the Biological Weapons Convention, it has pursued BW capabilities since the 1960s and reportedly conducts research on the biological agents that cause anthrax, plague, smallpox, typhoid, and hemorrhagic fever. Given the advanced state of North Korean missile programs, it is capable of delivering intermediate-range warheads filled with chemical or biological agents.[\[10\]](#)

### Sudan

A party to the Chemical Weapons Convention, Sudan has pursued the capability to produce chemical warfare agents since the 1980s. Sudan has sought foreign assistance from a number of countries that have CW programs, including Iraq. During the 1990s, Sudanese officials allegedly produced chemical weapons in collaboration with Osama bin Laden's al-Qaeda terrorist network, although evidence in the public domain for this allegation remains equivocal.[\[11\]](#) There are no confirmed reports that Sudan is pursuing a biological weapons program.

### Syria

Syria has one of the largest and most advanced chemical warfare capabilities in the Middle East. With an estimated CW stockpile in the hundreds of tons, Syria is believed capable of producing and delivering

sarin and VX nerve agent, as well as mustard agent. Major Syrian CW production facilities are located near Damascus and Homs. Analysis indicates that Syria has chemical warheads for Scud ballistic missiles and chemical gravity bombs for delivery by aircraft. Syria's chemical warfare program remains dependent on foreign precursor chemicals and equipment, and it has continued to solicit foreign sources of these materials.[\[12\]](#) Syria has not signed the Chemical Weapons Convention.

Although it is likely that Syria is developing an offensive BW capability, evidence suggests that it is currently restricted to a research program.[\[13\]](#) With significant assistance from other proliferant states, however, Syria could acquire a BW production capacity. Syria has signed but not ratified the Biological Weapons Convention.

### *Sub-state Proliferation Concerns*

Trends in terrorism over the past two decades indicate a shift from political to religious motives. Today's most pernicious terrorists are not motivated by political ideology on the far left or right, but are more likely to be extremists on the fringe of traditional religions or idiosyncratic cults with an apocalyptic mindset. Because religion acts as a legitimizing force by subordinating individual responsibility to divine will, groups motivated by religious extremism experience fewer constraints on the use of violence to inflict indiscriminate casualties. For example, a millenarian ideology that espouses a belief in the imminence of Armageddon could serve to justify mass-casualty attacks. Many of this so-called "new breed" of terrorists have an almost mystical fascination with chemical and biological agents because of the ability of toxic weapons to instill a pervasive sense of dread and their similarity to biblical plagues. Over the past decade, there has been an upsurge of interest by sub-state groups in acquiring chemical and biological weapons. The best-known example occurred in March 1995, when the Japanese doomsday cult Aum Shinrikyo released sarin nerve agent in the Tokyo subway. Despite an estimated net worth of roughly \$1 billion and the active recruitment of chemists and biologists from Japanese universities to create a CBW arsenal, Aum was unable to achieve its deadly goals. Cult scientists tried initially to produce and deliver biological agents, including anthrax and botulinum toxin, but because of technical problems they failed to inflict any known casualties in nine attempted biological attacks. The cult then focused on acquiring a chemical weapons capability and succeeded in producing several gallons of sarin, as well as smaller amounts of VX and mustard agent.[\[14\]](#) Although Aum sought to inflict mass casualties in its March 1995 sarin attack on the Tokyo subway, the lack of an effective delivery system limited the impact to 12 deaths and a few hundred serious injuries. This attack fell far short of the cult's goal of killing tens of thousands of civilians, with the aim of triggering widespread anarchy and enabling Aum leader Shoko Asahara to seize control of the Japanese government.

Another terrorist group, the Kurdistan Worker's Party (PKK), has also demonstrated interest in CBW agents. Seydo Hazar, an ex-PKK member, told the British newspaper *The Observer* that he had been ordered to build a sarin bomb and that, after fleeing Turkey, he had left a cache of explosives and chemical precursors for sarin at a PKK safe house in Drosia, Greece.[\[15\]](#)

Of course, the most prominent non-state actor believed to be involved with CBW agents is Osama bin Laden. Numerous reports have claimed that Bin Laden has attempted to acquire unspecified chemical weapons from entities in Iraq and Sudan, and biological agents (including botulinum toxin, plague, and anthrax) from biological suppliers in the Czech Republic, Kazakhstan, and Indonesia. These claims have not been verified, however.[\[16\]](#)

### *Dual-Use Equipment and Technologies*

Nearly all of the materials and equipment used to make CBW agents are dual-use, complicating the

control, detection, and interdiction of proliferation-relevant exports.

## Chemical Agents

Chemical warfare agents can be produced using 40-year-old technology and synthetic methods that have been published in the open scientific literature. Certain World War I-era chemical warfare agents, such as phosgene, hydrogen cyanide, and sulfur mustard, are relatively easy to manufacture. There are, for example, at least nine documented synthetic methods for sulfur mustard<sup>[17]</sup>, and small quantities could be produced in a crude facility such as a basement laboratory. Nerve agents require more technical sophistication, primarily because of the difficult and hazardous cyanation and alkylation reaction steps. Although the Chemical Weapons Convention and the Australia Group (an informal forum of 33 exporting countries) restrict trade in chemical weapons precursors, determined proliferators have often circumvented these controls by purchasing controlled chemicals from unscrupulous suppliers and evading interdiction efforts by means of transshipment points and front companies. Thus, although export controls are a useful means for slowing proliferation, they do not constitute a long-term solution to the problem. Moreover, key chemical weapons precursors can themselves be produced (with substantial effort) from more basic chemicals, a strategy known as “back integration.” Many of these more basic substances are commodity chemicals that are widely used in industry to make pharmaceuticals, pesticides, and other commercial products. In the early 1980s, for example, Iraq was initially unable to produce thiodiglycol, a key ingredient in the production of mustard agent, and ordered more than 1,000 tons of this chemical from foreign suppliers, including a company in the United States. When the Australia Group countries agreed to halt exports of thiodiglycol to Iraq, the Iraqis developed a way to produce this precursor indigenously by reacting ethylene oxide with hydrogen sulfide.<sup>[18]</sup> Moreover, states or terrorists need not attempt to purchase CW precursors if they seek a limited chemical warfare capability for use against civilians. Several chemicals not usually classed as battlefield weapons are still highly toxic, such as organophosphate insecticides. While not as lethal as sarin or soman, these “second tier” chemical agents have similar physiological effects to nerve agents and are far more accessible.

Almost all of the equipment used to produce CW agents is dual-use and available to almost any country, and no “smoking gun” items of equipment exist. A state seeking to minimize the health and safety risks associated with CW production would probably seek to acquire corrosion-resistant reactor vessels and pipes, as well as special ventilation and waste-handling equipment. Nevertheless, states or groups wishing to conceal a clandestine CW program from Western intelligence agencies could cut corners on worker safety or environmental protection in an effort to minimize the telltale “signatures” of illicit production. Indeed, Iraq sought to conceal the manufacture of chemical warfare agents in ostensibly civilian facilities engaged in the production of pesticides.

## Biological Agents

The dual-use problem is even more acute with respect to the production of biological warfare agents, such as anthrax and botulinum toxin. Pathogenic microbes are widely available, either from the natural environment in areas where diseases such as anthrax or plague are endemic, or from the hundreds of culture collections scattered across the globe that provide seed stocks for biomedical researchers and commercial biotechnology firms.<sup>[19]</sup> The various types of nutrient media (“broth”) needed to grow microorganisms are ubiquitous and widely traded. Because bacteria will multiply exponentially under optimal culture conditions, a small seed stock of cultures can yield large amounts of agent over a period of days or weeks. This situation is further complicated by the fact that some dangerous pathogens are not

only studied by biomedical researchers but have also become commercial products. For example, pharmaceutical companies currently produce large quantities of botulinum toxin (trade name Botox) for medical and cosmetic purposes.

The equipment used to produce biological agents is almost entirely dual-use: stainless-steel fermenters suitable for growing anthrax are routinely used to produce legitimate products such as vaccines, vitamins, food supplements, biopesticides, and fermented beverages. A multitude of companies manufacturing this equipment has grown up to service the burgeoning biotechnology industry, complicating attempts to impose restrictive export controls. Even freeze-drying (lyophilization) and milling machines, which can be used to convert bacterial or viral agents into a dry powder for optimal dissemination as a fine-particle aerosol, have become standard equipment in the pharmaceutical industry.

Military facilities that produce biological weapons are nearly indistinguishable from civilian vaccine plants, particularly if a proliferator deliberately eschews measures for environmental protection and worker safety. Iraq, for example, converted ostensibly commercial facilities such as vaccine plants or single-cell protein factories for illicit BW agent production campaigns. Technological advances such as computer-controlled, continuous-flow fermenters and hollow-fiber bioreactors have greatly reduced the size of a facility capable of producing large quantities of BW agents. Moreover, fermentation tanks equipped with "clean-in-place" technology make it possible to remove the telltale residues of BW agent production in a matter of hours. As a result, detection of military production has become substantially more difficult.

Nevertheless, chemical and biological agents do not become effective weapons unless there is a means to deliver them. Manufacturing specialized CBW munitions, such as artillery shells and missile warheads, requires a high degree of technical sophistication, but several more primitive delivery systems are dual-use. Unmodified agricultural sprayers (such as crop-dusters) are not well suited for disseminating biological agents, but these devices could be used to spread chemical agents over a fairly large area, provided that the perpetrator takes precautions when filling the sprayer tanks and is aware of meteorological dynamics. Some agents, such as sarin, do not burn readily and hence could be dispersed with an explosive charge. Both of these delivery methods would be within reach of most states and certain sub-state terrorist groups.

### *Accessibility to Dual-Use Technologies*

Attempts to regulate exports of dual-use technologies to countries of proliferation concern have faced resistance not only from non-aligned states that claim that such trade restrictions are discriminatory, but also from international suppliers, companies, and research institutes that benefit from the commercial sale and transfer of these technologies.

Another problem is that chemical and biotechnology companies are no longer confined to the highly industrialized countries of the West. In a number of developing countries, the availability of turnkey production facilities, an increasingly skilled work force, and low labor and regulatory costs have encouraged governments to promote these industries as a driver of economic growth. This trend has resulted in international trade in a wide variety of chemicals amounting to millions of tons per year, as well as a growing interest in indigenous production of generic pharmaceuticals and vaccines. Although the manufacturing processes utilized in developing countries may be a generation or two behind those in the United States and Europe, they are still more than adequate to produce chemical and biological warfare agents.

The burgeoning global commerce in the chemical and biotechnology sectors has also spurred technological advances, some of which could facilitate the production of chemical or biological weapons by state or non-state actors. One example is the advent of microreactors that can process large volumes of

chemicals, yet are small enough to be disguised as laboratory equipment.[20] The expanding global commerce in dual-use technologies will continue to make it easier for state and sub-state actors to acquire chemical and biological weapons. A number of cases illustrate this ominous trend: Iran has relied heavily on foreign assistance to establish its nonconventional weapons programs. Over the past few years, the Iranian government has attempted to acquire CW precursor chemicals, production technology, and scientific expertise from Russian and Chinese suppliers. Iran has also attempted to acquire dual-use biological materials from foreign suppliers, ostensibly for civilian purposes.[21] Iraq received extensive foreign assistance to establish its offensive BW program. Between 1985 and 1989, U.S. suppliers exported to Iraq cultures of *Bacillus anthracis* (anthrax), *Clostridium botulinum* (botulism), *Histoplasma capsulatum*, *Brucella melitensis* (brucellosis), *Clostridium perfringens* (gas gangrene), *Clostridium tetani* (tetanus), and other dangerous pathogens.[22] In the 1980s, Iraq's State Establishment for Pesticide Production ordered and received incubators and culture media from West Germany.[23] Many of the dual-use materials that Iraq ordered from foreign sources, under civilian cover, ended up in biological weapons research. Agents of the Aum Shinrikyo cult purchased *Clostridium botulinum* from a pharmaceutical company[24], 16 industrial-grade filters from an Osaka pharmaceutical company, and chemical precursors and technologies from other commercial suppliers.[25]

### *State-Sponsors of Terrorism*

Further compounding the threat to U.S. interests from the continued proliferation of chemical and biological weapons is the possibility that rogue regimes could supply CBW materials, equipment, know-how, or even finished weapons to terrorist organizations. As the number of states with CBW capabilities rises, the risk of direct or indirect transfer to terrorists will increase. Of all state-sponsors of terrorism, Iran is considered the most energetic.[26] Despite Tehran's official condemnation of the September 11 attacks, it is still considered a sponsor of Hamas, Hizbollah, and Islamic Jihad, and may have provided these groups with CBW training and materials before any recent change of heart. The rise of the (relatively) moderate Mohammad Khatami in recent years has done nothing to halt this behavior. Conservatives still control the Iranian military and intelligence services, and it is estimated that Iran provides more than \$100 million in aid to terrorist organizations each year.[27] Such efforts are directed mainly by the Islamic Revolutionary Guards Corps (IRGC), controlled by hard-line ayatollahs who are also responsible for Iran's weapons of mass destruction programs.

Before Iran became a vigorous supporter of such groups, Libya was considered the overlord of international terrorism. As recently as 1996, Libya provided support and possibly training bases for the Abu Nidal Organization, Palestinian Islamic Jihad, and the Popular Front for the Liberation of Palestine—General Command. Recently, however, Libyan leader Muammar Qaddafi has appeared to moderate his behavior. In addition to extraditing the Pan Am 103 bombers for trial, Qaddafi has reportedly cut ties with some radical groups such as Hamas.[28] Nevertheless, the State Department maintains that Libya maintains contact with other terrorist groups, including Islamic Jihad.[29] U.S. government officials are also concerned about Libya because of its known chemical warfare capability and its close relationship with Iraq.[30]

Finally, Iraq's substantial experience with chemical and biological weapons is well-known. As a state-sponsor of terrorism, Iraq has supported the Abu Nidal Organization and the Palestine Liberation Front, although not as generously as Iran. Saddam Hussein's defiant and often erratic behavior, his enduring hatred of the United States and Britain, and his history of attempting to enhance his stature as a

regional hegemon, suggest that the transfer of Iraqi CBW materials or know-how to terrorists cannot be ruled out.

## Conclusions

In recent years, the growing availability of dual-use technologies, materials, information, and expertise associated with the production and delivery of chemical and biological weapons has exacerbated the CBW proliferation problem. Indeed, the relative ease of acquiring these weapons has increased their attractiveness to proliferant states that cannot afford to acquire advanced conventional or nuclear weapons or lack the necessary technical capabilities. Moreover, history has shown that both state suppliers and unscrupulous companies are willing to sell sensitive technologies and materials to customers willing to pay. The legacy of the Soviet chemical and biological weapons programs, and the proliferation of these weapons to other countries, has also increased the risk that sub-state groups could acquire relevant technologies by stealing them from unguarded facilities or by recruiting unemployed former Soviet weapons scientists.

Given the dual-use dilemma and the rapid diffusion of legitimate chemical, pharmaceutical, and biotechnology industries around the globe, strengthened CBW export controls can buy time, but they do not offer a long-term solution to the proliferation problem. Accordingly, export controls must be seen as one of a set of policy tools for addressing the CBW proliferation threat, together with active interdiction efforts, passive and active defenses, strengthened consequence management capabilities, nonproliferation efforts in the former Soviet Union, and multilateral arms control. Although the Bush administration has taken a skeptical attitude toward arms control, a strengthened international legal regime banning the possession and use of chemical and biological agents, backed up by a credible threat of severe economic sanctions and military action against violators, offers an important tool for reversing the spread of these heinous weapons. Although the Chemical Weapons Convention (CWC) and the Biological Weapons Convention (BWC) impose blanket prohibitions on such weapons, both regimes have serious weaknesses that currently undermine their effectiveness. Given the dangerous precedent that has now been set by the actual use of anthrax against civilian targets in the United States, it is vital for the international community to strengthen both treaties to promote the international norm of non-use and possession by states of concern and, by extrapolation, sub-state actors as well.

For example, the United States has repeatedly accused Iran, a party to the CWC, of systematically violating its treaty obligations. A Central Intelligence Agency report to Congress in August 2000 stated that "Iran, a . . . CWC party, already has manufactured and stockpiled chemical weapons, including blister, blood and choking agents and the bombs and artillery shells for delivering them. During the second half of 1999, Tehran . . . acquired or attempted to acquire indirectly through intermediaries in other countries equipment and material that could be used to create a more advanced and self-sufficient CW infrastructure."<sup>[31]</sup> Despite such allegations, however, Washington has failed to request a challenge inspection of Iran as permitted under the CWC, undermining the credibility of the treaty's verification regime.

With respect to the BWC, the Bush administration decided in July 2001 to withdraw from a six-year effort to negotiate a legally binding compliance regime. Although the administration has proposed as an alternative a package of voluntary proposals, these measures appear insufficiently intrusive or effective to deter violations or to enhance compliance with the treaty.<sup>[32]</sup> The Administration should work with our European allies to strengthen some of the proposals by making them legally binding. Finally, in response to the anthrax attacks, the United States should devote greater political and financial

capital to strengthening the CWC and the BWC, make more effective use of existing treaty instruments (e.g., by requesting a CWC challenge inspection of Iran and other suspected violators), and seek to brand the possession and use of chemical and biological weapons as a “crime against humanity” under international law.

---

[1] I am grateful to Cheryl Loeb and Gary Ackerman of the Monterey Institute for their invaluable assistance in preparing this testimony.

[2] U.S. Central Intelligence Agency, “Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 July Through 31 December 2000,” September 7, 2001 <[http://www.cia.gov/cia/publications/bian/bian\\_sep\\_2001.htm](http://www.cia.gov/cia/publications/bian/bian_sep_2001.htm)>; Javed Ali, “Chemical Weapons and the Iran-Iraq War: A Case Study in Noncompliance,” *Nonproliferation Review* 8(1), Spring 2001, p. 43-58; Kelly Motz, “What Has Iraq Been Doing Since Inspectors Left? What Is On Its Shopping List?” *Iraq Watch*, <http://www.iraqwatch.org/updates/update.asp?id=wpm200107231601>; United Nations Special Commission on Iraq (UNSCOM), “Report: Disarmament,” January 25, 1999, <http://cns.miis.edu/research/iraq/ucreport/index.htm>; Steve Bowman, “Iraqi Chemical and Biological Weapons (CBW) Capabilities” (Washington, D.C.: Congressional Research Service, February 17, 1998), pp. 1-5; U.S. Government White Paper, “Iraq Weapons of Mass Destruction Programs,” February 13, 1998, [http://www.state.gov/www/regions/nea/iraq\\_white\\_paper.html](http://www.state.gov/www/regions/nea/iraq_white_paper.html); Anthony H. Cordesman, *Weapons of Mass Destruction in the Middle East: Regional Trends, National Forces, Warfighting Capabilities, Delivery Options, and Weapons Effects*, Center for Strategic and International Studies, June 2001, <[http://www.csis.org/burke/mb/me\\_wmd\\_mideast.pdf](http://www.csis.org/burke/mb/me_wmd_mideast.pdf)>, pp. 75-79; United Nations Special Commission (UNSCOM), “UNSCOM Main Achievements,” May 1998, <<http://www.un.org/Depts/unscom/achievement.htm>>; Physicians for Human Rights, *Winds of Death: Iraq's Use of Poison Gas Against its Kurdish Population* (Boston, MA: Physicians for Human Rights, February 1989), pp. 1-2.

[3] United Nations Special Commission on Iraq (UNSCOM), “Report: Disarmament,” January 25, 1999, <http://cns.miis.edu/research/iraq/ucreport/index.htm>; Motz, “What Has Iraq Been Doing Since Inspectors Left?”; Bowman, “Iraqi Chemical and Biological Weapons (CBW) Capabilities”; Barbara Starr, “UNSCOM Inspectors Still Doubt Iraq's Arms Claims,” *Jane's Defence Weekly*, February 25, 1998, p. 18; U.S. Government White Paper 1998; Cordesman, *Weapons of Mass Destruction in the Middle East*, 2001, pp. 81-84; Jonathan B. Tucker, “Lessons of Iraq's Biological Weapons Programme,” *Arms Control/Contemporary Security Policy*, 14(3), December 1993, pp. 229-271.

[4] E.J. Hogendoorn, “A Chemical Weapons Atlas,” *Bulletin of the Atomic Scientists*, September 10, 1997, p. 37; Gregory F. Giles, “The Islamic Republic of Iran and Nuclear, Biological, and Chemical Weapons,” in *Planning the Unthinkable*, Peter Lavoy, Scott Sagan, and James Wirtz, eds., (Ithaca, NY: Cornell University Press, 2000), pp. 79-103; W. Seth Carus, “Iran's Weapons of Mass Destruction: Implications and Responses,” *Middle East Review of International Affairs*, 1998, 2(1), pp. 1-14; Henry L. Stimson Center, “CWC Status: States of Chemical Weapons Proliferation Concern,” May 27, 1998 <<http://www.stimson.org/cwc/status.htm>>; Office of the Secretary of Defense, “Iran: Objectives, Strategies and Resources,” *Proliferation: Threat and Response* (Washington, DC: U.S. Department of Defense, 1997) <<http://www.defenselink.mil/pubs/ptr20010110.pdf>>, pp. 3-4; Michael Eisenstadt, *Iranian Military Power: Capabilities and Intentions* (Washington, DC: Washington Institute for Near East Policy, 1996), pp. 9-25; Anthony H. Cordesman, “Weapons of Mass Destruction in the Middle East: National Efforts, War Fighting Capabilities, Weapons Lethality, Terrorism, and Arms Control Implications,” (Washington, DC: Center for Strategic and International Studies, February 1998), pp. 22-24; Centre for Defence and International Security Studies (CDISS), “Devil's Brew Briefings: Iran,” <<http://www.cdiss.org/cbwnb1.htm>>.

[5] Cordesman, “Weapons of Mass Destruction in the Middle East,” February 1998, p. 24; Centre for Defence and International Security Studies (CDISS), “Devil's Brew Briefings: Iran,” p. 24; Office of the Secretary of Defense, “Iran: Objectives, Strategies and Resources,” p. 5; U.S. Arms Control and Disarmament Agency, *Adherence to and Compliance with Arms Control Agreements* (Washington, DC: U.S. Government Printing Office, August 1996), p. 68.

[6] Office of the Secretary of Defense, “Proliferation: Threat and Response,” January 2001, p. 47.

[7] Robert M. Gates quoted in William Tuohy, “U.S. Pressing Allies on Libya Chemical Plant,” *Los Angeles Times*, January 3, 1989, p. 10.

[8] Office of the Secretary of Defense, *Proliferation: Threat and Response*, pp. 47.

[9] *Ibid.*, p. 9.

[10] *Ibid.*

[11] Michael Barletta, “Chemical Weapons in the Sudan: Allegations and Evidence,” *The Nonproliferation Review*, Fall 1998, <<http://cns.miis.edu/pubs/npr/barlet61.htm>>, pp. 115-36.

[12] Michael Eisenstadt, “Syria's Strategic Weapons,” *Jane's Intelligence Review*, May 1993, p. 170. Office of the Secretary of Defense, “Syria: Objectives, Strategies and Resources,” *Proliferation: Threat and Response*, (Washington, DC: U.S. Department of Defense, 1997), pp. 18-19. Cordesman, “Weapons of Mass Destruction in the Middle East,” 2/98, p. 21. “Devil's Brews Briefings: Syria,” Centre for Defence and International Security Studies (CDISS), 1996 <<http://www.cdiss.org/cbwnb5.htm>>. Ahmed S. Hashim, *Chemical and Biological Weapons and Deterrence Case Study 1: Syria* (Alexandria, VA: Chemical and Biological Arms Control Institute, 1998), p. 5. Uzi Mahnaimi, “Syria Builds Nerve Gas Arsenal,” *London Sunday Times*, November 17, 1996 <<http://personal.the-times.co.uk:80>>. Paul Beaver, “Syria To Make Chemical Bomblets For Scud Cs,” *Jane's Defence Weekly*, September 3, 1997, p. 3.

[13] Office of the Secretary of Defense, *Proliferation: Threat and Response*, January 2001.

[14] David E. Kaplan, “Aum Shinrikyo (1995),” *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker, ed,

(Cambridge, MA: MIT Press, 2000), p. 221.

[15] Republic of Turkey, Ministry of Foreign Affairs, "Excerpts from News Reports, Commentaries and Statements on PKK Terrorism," 09/28/97, <<http://www.mfa.gov.tr/grupe/eh/eh04/01.htm>>; Nils Lathem, "Osama Bought a Batch for 10G," NYPost.com <<http://www.nypost.com/news/worldnews/32458.htm>>.

[16] Simon Reeve, *The New Jackals: Ramzi Yousef, Osama bin Laden* (Boston, MA: Northeastern University Press, 1999).

[17] Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, December 1993, pp. 21-22.

[18] *Ibid.*, p. 23.

[19] U.S. culture supply houses are now under stricter federal controls, but comparable controls do not apply to culture collections overseas. See Jonathan B. Tucker, "How to Regulate the Trade in Toxins" [op-ed], *New York Times*, October 26, 2001, p. A23.

[20] Scientists at DuPont and MIT have used microreactors to produce hydrogen cyanide and phosgene, two chemical warfare agents. See Nicolas P. Chohey with G. Ondrey and G. Parkinson, "Microreactors Find New Niche," *Chemical Engineering*, March 1997, pp. 30-33.

[21] Office of the Secretary of Defense, "Proliferation: Threat and Response," January 2001 <<http://www.defenselink.mil/pubs/ptr20010110.pdf>>.

[22] William Blum, "Anthrax for Export: U.S. Companies Sold Iraq the Ingredients for a Witch's Brew," *The Progressive* 4, April 1998, p. 18.

[23] *Der Spiegel*, FBIS-WEU-90-196, "We Have Surprises," October 8, 1990, pp. 148-152.

[24] Robert Guest, "Cult Germ Was Claim as Police Find Bacteria," *Daily Telegraph*, March 29, 1995, p. 13.

[25] Mainichi Daily News, "Bacteria Used in Germ Warfare Found at Cult Site," March 29, 1995, p. 1; Kyodo, "Aum Bought Experimental Cells Before Subway Gas Attack," May 18, 1995.

[26] U.S. Department of State, Office of the Coordinator for Counterterrorism. "Overview of State-Sponsored Terrorism," *Patterns of Global Terrorism 2000*, April 2001, <<http://www.state.gov/s/ct/rls/pgtrpt/2000/>>.

[27] Boaz Ganor, "Countering State-Sponsored Terrorism", <<http://www.ict.org.il/articles/articledet.cfm?articleid=5#Conflicts>>, p. 4.

[28] Ray Takeyh, "The Rogue Who Came in From the Cold," *Foreign Affairs*, May-June 2001.

[29] U.S. Department of State, Office of the Coordinator for Counterterrorism. "Overview of State-Sponsored Terrorism."

[30] In the late 1980s, evidence surfaced that Libya had built two large chemical weapons facilities, including a secret underground plant at Tarhunah. The CIA also fears Libya may have engaged in joint BW development activities with Iraq.

[31] Central Intelligence Agency, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 July Through 31 December 1999," available on-line at [http://www.cia.gov/cia/publications.bian/bian\\_aug2000.htm](http://www.cia.gov/cia/publications.bian/bian_aug2000.htm).

[32] White House, Office of the Press Secretary, "Statement by the President: Strengthening the International Regime Against Biological Weapons," November 1, 2001.