The 1979 Anthrax Epidemic in the USSR: Applied Science and Political Controversy

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In March 1980, the United States confronted the Soviet Union with suspicions it was violating the 1972 Biological Weapons Convention (BWC). The evidence was sparse, but potentially damning. For months, rumors had been circulating that, sometime in the spring of 1979, tens or hundreds of people had died of anthrax accidentally emitted from a military laboratory in the industrial city of Sverdlovsk. The CIA was aware that Sverdlovsk harbored a high-security military base, called Compound 19, with a biology laboratory. But were the Soviets only testing anthrax vaccines with lethal aerosols, or were they engaged in the illegal development of biological weapons?

In response to the U.S. allegation, the Soviet government admitted that an epidemic of anthrax had occurred in Sverdlovsk in April–May 1979, but explained that it had been a natural outbreak, caused by an epizootic. Sixty-four people in Sverdlovsk, nine hundred miles east of Moscow, had died of eating meat infected with the deadly bacterium *bacillus anthracis*. It took eight years before Soviet officials gave a detailed account of the event.

In April 1979, three Moscow physicians (a public health administrator, an infectious disease specialist, and an epidemiologist) were sent to Sverdlovsk to supervise the response to the outbreak. In October 1986, Harvard biologist Matthew Meselson, a long time government consultant and advocate for biological and chemical weapons arms...
control, met with them in Moscow. It was the beginning of glasnost and more open communication in the Soviet Union. Meselson recommended the physicians write up their account and publish it, and also that they consider speaking to anthrax experts and government officials in the United States. Soon after, also in Moscow, a National Academy of Sciences committee headed by Joshua Lederberg was given a formal presentation by the infectious disease expert Dr. Vladimir Nikiforov; afterward members of the committee interviewed him informally. In April 1988, two of the three physicians (Dr. Nikiforov and Dr. Pyotr Burgasov, Soviet deputy minister of public health in 1979) arrived in Washington. They gave their first presentation at the National Academy of Sciences in Washington, D.C., to a large, invited audience that included scientists, physicians, and U.S. and British intelligence officers. They gave their presentation twice more, to large audiences at the Johns Hopkins School of Public Health in Baltimore and at the American Academy of Arts and Sciences in Cambridge. Later in 1988, the Soviet Ministry of Foreign Affairs submitted a seventeen-page account of the Sverdlovsk outbreak, its infected meat source, and its repercussions, to the U.S. State Department.

This Soviet version of the 1979 anthrax outbreak pointed to a public health failure, namely, that animal feed infected with anthrax spores had provoked an epizootic. Thus, livestock deaths occurred just south of Sverdlovsk, and meat from these animals was trucked to the city and sold. Between 4 April and 18 May, the documentation indicated, sixty-four people died of massive anthrax infection and fifteen survived, with intensive clinical management. Human anthrax was not unknown in the USSR. This unusually large outbreak, the Soviets pointed out, resembled a much earlier one in 1927 in the town of Yaroslavl, northeast of Moscow, in which twenty-seven people died of eating anthrax-infected sausage.

Since 1980, Meselson and other experts consulted by the CIA had puzzled over the long duration of the epidemic. According to what was then known about rare cases, deaths from inhalation anthrax would occur within two to seven days after exposure. By the Soviet account, the Sverdlovsk deaths peaked in a week, on 10 April, yet cases kept

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3 The two physicians were accompanied by a third, Dr. Vladimir Sergiev, who had been Dr. Burgasov’s assistant in the Ministry of Public Health in 1979.

4 Of the ninety-six, seventeen were said to have had cutaneous anthrax, fifteen to have had intestinal anthrax and survived, and sixty-four to have died of intestinal anthrax. For a description of the different forms of the disease and their treatment, see T. C. Dixon, M. Meselson, J. Guillemin, and P. C. Hanna, “Medical Progress: Anthrax,” New England Journal of Medicine 341.11 (2000): 815–26.
emerging until mid-May. The Soviet explanation was that anthrax-infected meat was kept in homes and eaten over the five-week period. The scenario the CIA settled on was that some kind of anthrax aerosol caused the early deaths and also infected livestock, whose contaminated meat caused the later deaths.⁵

From 1983 onward, Meselson attempted to arrange an on-site investigation in Sverdlovsk. Speaking in congressional testimony and to the media, he emphasized the importance of a scientific investigation of the Sverdlovsk outbreak. Meanwhile, the U.S. kept the epidemic prominent in its annual declaration of Soviet noncompliance with arms control agreements, asserting that “the Soviet Union has maintained an offensive biological warfare program and capability in violation of its legal obligation [under the BWC].”⁶ But the U.S. stopped short of a formal complaint to the United Nations Security Council, as provided for under the Biological Weapons Convention. The Soviet account, though plausible, was backed by only rudimentary, unverified data. The issue of Soviet noncompliance remained unresolved.

The 1992 Trip to Ekaterinburg

In early 1992, just after the fall of the Soviet Union, Meselson contacted the Russian health and environment advisor to President Yeltsin, Alexey Yablokov, a zoologist. Dismissing any Sverdlovsk investigation as too late, Yablokov nonetheless recommended that Meselson seek an invitation from a host institution in Sverdlovsk, now known by its historic name of Ekaterinburg. That invitation, from the Ural State University, came through in April 1992. Meselson put together a team of five Americans⁷ and a Moscow physician, Dr. Olga Yampolskaya, a clinical assistant to Dr. Nikiforov in Sverdlovsk during the 1979 outbreak. The finalization of our early June travel schedule was communicated to Yablokov, who presumably informed President Yeltsin, the Sverdlovsk Communist party head at the time of the 1979 outbreak.

Unknown to us, Yeltsin had been lobbied by a city representative, Larissa Mishustina, to document the cause of the epidemic and to grant pensions to the families of victims. The KGB had supplied Mishustina with a list of victims’ names for this compensation. Also unknown

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⁷ Dr. Yampolskaya was at the Botkin Hospital, Moscow. The other members of the team were Dr. Martin Hugh-Jones from Louisiana State University, Dr. Alexis Shelokov from the Salk Institute, Dr. David Walker from the University of Texas, Galveston, myself, and Meselson.
to us, just days before our arrival, Yeltsin had told Moscow reporters that in 1979 the KGB informed him that the military was the cause of the anthrax epidemic, but that he believed the Compound 19 program was abolished soon after the incident. At that point President Yeltsin was about to depart for Washington, where he would tell the U.S. Congress that Russia had terminated all Soviet biological weapons programs. These assertions aside, we were looking for facts.

I arrived in Ekaterinburg with a hundred copies of my questionnaire for the families of victims, but I had no idea how to locate them in this large industrial city. I knew a few names, gleaned from Russian press accounts. Starting in August 1990, Moscow journalists had been reporting their doubts about the bad meat explanation of the Sverdlovsk outbreak. Casting suspicions on Compound 19, they had quoted by name several relatives of victims, along with physicians and a few retired military officers. Following their lead, the Wall Street Journal later reported similar statements. But the information throughout was anecdotal. Understanding that the epidemic had most affected the southeast section of the city, we had brought along Western maps of Sverdlovsk, but these were inaccurate. Ultimately, the university and local networks gave us some of the contacts we needed, and the maps we purchased in an Ekaterinburg store proved accurate. Ten days after our arrival, Larissa Mishustina gave us a copy of the KGB list of deceased victims, with their 1979 home addresses. These residences when plotted on the city map (Fig. 1) showed, as the Soviet account had described, that around a third of the victims lived beyond the southeastern area, far from Compound 19.

Sound epidemiology demanded that we distinguish valid anthrax cases from invalid ones. By cross-checking public health information, medical documents, and, ultimately, fifty-six interviews with families

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8 D. Muratov, Y. Sorokin, and V. Fronin, “Boris Yeltsin: I Am Not Hiding the Difficulties and I Want the People to Understand This,” Komsomolskaya Pravda, 27 May 1992: 2. Yablokov would later tell us that the KGB records about Sverdlovsk had been destroyed. The wording of the decree for the family pensions specifically holds the military immune from legal liability. See Anthrax, 163–66.


10 See Peter Gumbel, “The Anthrax Mystery,” Wall Street Journal, 21 October 1991: A12, and two additional editorials that followed on 22 and 23 October. Gumbel drew on Zhenova’s accounts and those of other Russian journalists to critique the official Soviet version of the outbreak. Mistakes in his descriptions of the Sverdlovsk southeast area suggest either that he never visited it or that his notes were disorganized.
Figure 1. Map of the residences of the 1979 Sverdlovsk anthrax victims from the KGB list, with four additional cases added in 1992. Circles indicating locations are placed on a 1988 SPOT satellite photograph of Sverdlovsk, which matched the city maps we used in 1992. Arrows indicate addresses outside the city.
and neighbors, we sought to ascertain whether those listed by the KGB had indeed died of anthrax, and also whether, among others who were sick or died in the same April-May period, more anthrax victims might be found. The cemetery where anthrax victims had been buried yielded sixty-one legible names and birth and death dates from grave markers. As part of the Sverdlovsk public health response, dozens of patients had been screened at clinics and hospitals. We were able to obtain medical lists that distinguished between those suffering from cardiac arrest or other serious medical problems, and those diagnosed with anthrax. Two Sverdlovsk pathologists (Dr. Faina Abramova and Dr. Lev Grinberg) working in 1979 had also made judgments about cause of death in a series of nearly a hundred autopsies they performed; of these they identified forty-two as having had anthrax. Abramova’s clinical notes gave the names and onset and death dates for these cases. Their cases were also on the KGB list, with the exception of one man found dead with no identification. We were able to obtain detailed clinical records for five survivors. Eventually we had sixty-six valid fatal cases and eleven survivor cases, each verified by multiple sources.

The victims’ home addresses told us where they most probably were at night in early April 1979. A crucial objective of the family interviews was to establish their daytime locations in that same period, just before the epidemic began. We understood that a number of workers at the ceramic factory in the southeastern part of the city had been affected by the epidemic. For them, as for the other victims, daytime location proved vital to explaining why they died. Over the better part of two years, it would take the assistance of our Ural State University colleagues and two trips to Ekaterinburg to gather sufficient information to plot the daytime locations of victims identified as valid cases (Fig. 2).

In contrast to the dispersed nighttime locations, the daytime locations of the victims fall into a narrow zone extending southeast from Compound 19.11 On the north, this military base borders a forested area and to the south it abuts Compound 32, where eleven people were infected. Five of those victims were men who otherwise lived and worked outside the area, but they were present at Compound 32 for required military reserve courses given on 2–6 April 1979, from 8:30 a.m. to around 4:30 p.m. One of the military reservists was present only on Monday, 2 April. The earliest reported date of onset among the verified anthrax cases was 4 April. One survivor of the epidemic was a baker who routinely left her home near the ceramics factory

11 Six outliers are located outside the plume. Their daytime locations either involve mobile activities, such as truck driving or telephone repair, or could not be confirmed by interview.
Figure 2. Map of the daytime locations of sixty-two victims in the southeastern area of the city. Four additional locations are outside this map’s boundaries, to the north and west. The irregular areas outlined in white indicate the two military bases. Compound 19 to the north was the source of the 2 April anthrax emission; Compound 32 is to the south. The rectangle to the southeast is the ceramics factory. The elliptical shapes (isopleths) indicate areas of decreasing concentration of dose, moving outward from the source.
before 6:00 a.m. and returned in the early afternoon, before 2:00 p.m. These facts indicated that the emission from Compound 19 took place sometime in the afternoon of 2 April.

Sverdlovsk wind data for the last days of March and early April were obtained from archived local airport reports. On just one day, Monday, 2 April 1979, the wind blew all day from the northwest to the southeast, from Compound 19 directly toward the ceramics factory (Fig. 3). The distribution of the victims’ daytime locations reflects this wind direction exactly. At the northwest tip of the elliptical shapes (isopleths, the lines of estimated dosage) drawn in Figure 3 is Compound 19. The anthrax spores must have been blown from the compound over the homes, schools, shops, and factories to the southeast. The highest concentration of anthrax spores would have been within the innermost isopleth, with the dosage of spores diminishing as the plume moved downwind and widened.

In sum, rigorous epidemiological evidence proved that a lethal aerosol emission came from Compound 19 on Monday, 2 April 1979,
and thereby convincingly disproved the Soviet infected-meat explanation of the Sverdlovsk anthrax outbreak.

The 1993 Trip

Certain aspects of a public health response to an epidemic can sidestep the question of its cause. In Sverdlovsk, emergency committee meetings, the screening and intensive clinical care of patients, the mobilization of hundreds of women volunteers for house-to-house health checks, the distribution of antibiotics to families of victims, and the disinfection of victims’ sick rooms—all these important measures were carried out without reference to whether the anthrax was from an epizootic or from an aerosol. Posters and fliers warned citizens of the hazards of bad meat, and meat was confiscated from some victims’ homes and from vehicles entering the city from the south. Other public health responses were ambiguous. For example, by a directive from Dr. Burgasov, the exterior of the ceramics factory was washed down with disinfectants. Was this with a mind to reducing hazards from airborne spores? Starting in mid-April, fifty thousand people in the southeast area were vaccinated against anthrax. Was this to protect local citizens from the Compound 19 facility or from bad meat? Had there truly been an epizootic? During our 1992 trip, we made no contact with veterinarians, nor were we able to visit the villages where livestock had reportedly died of anthrax in 1979.

In August 1993, Meselson and I returned to Ekaterinburg to continue the Sverdlovsk anthrax investigation. In particular, we wanted facts about any animal outbreak in April 1979. Original Soviet veterinary reports given to us by Dr. Burgasov showed that, although some farm animals had died in late March, no laboratory-certified anthrax deaths among livestock were recorded until 4 April 1979. These animal deaths were recognized a week before the human cases in Sverdlovsk were finally diagnosed as anthrax (on 11 April), but they occurred just as the first victims in the city were coming down with symptoms. We drove fifty kilometers southeast of the city limit to the outermost village (Abramovo) described in the documents. There women from five families confirmed the documented deaths of their livestock and the public health response, which included vaccinations of animals and people, road blocks to check for meat, and a quarantine of the six affected villages. The sites of these villages (Fig. 4) are located along an extension of the same narrow zone as in Figure 2. Whether the infected animals inhaled the anthrax spores or ate them from the ground is unknown. What is sure is that, even as the concentration of anthrax spores diffused over the countryside, the agent maintained considerable lethality.
A solution to the puzzle of the relatively long duration of the outbreak was suggested by animal experiments done by the U.K. and the U.S. in the early 1960s, and generally disregarded after their biological weapons programs ended.\textsuperscript{12} That research suggested that anthrax

spores can remain dormant but viable in the primate lung as long as ninety days after inhalation, and could therefore cause a delayed fatal infection. Our team’s pathologist, Dr. David Walker, had inspected the 1979 autopsy data and slides, and with Drs.Yampolskaya, Abramova, and Grinberg, wrote a summary article for publication in English. Prior to our 1993 trip, Meselson edited the article and submitted it to the Proceedings of the National Academy of Sciences.13 The Abramova-Grinberg data and slides showed that victims died of inhalation anthrax as long as forty-three days after exposure. Once infection began, as clinical data and family interviews agreed, the time until death was short, usually two or three days.

An alternative explanation of the epidemic’s duration, popular in the Russian media in the 1990s, was that the later cases were caused by wind-borne spores re-aerosolized weeks after the 2 April emission. But aerosolized anthrax spores are not like dust particles. Released outdoors, only a small proportion of them would settle beneath the plume, and even these spores would stick to soil, vegetation, and other surfaces, from which they would be most unlikely to be resuspended as a respirable aerosol. In addition, anthrax spores, hardy but not indestructible, are destroyed by prolonged exposure to sunlight and by competing soil microorganisms.

Are some people more susceptible to inhalation anthrax than others? A curious finding of our research was that no one under the age of twenty-four died of inhalation anthrax in the Sverdlovsk epidemic, although many young people and children were present within the narrow zone in April 1979. Older people appeared vulnerable to the anthrax spores. The median age of victims was forty-two for men and forty-five for women, and the ratio of men to women was two to one.

Secrecy and the Cold War

A full description of activities at Compound 19 has yet to emerge, and the exact cause of the Sverdlovsk anthrax emission remains unknown. According to military personnel we interviewed in Moscow, lethal anthrax aerosol was being used at Compound 19 to challenge vaccinated laboratory animals. Claiming a lack of records from 1979, they offered no more information.14 Perhaps a defective filter for an animal


14 Military officials also questioned why, if an emission came from Compound 19, the
test chamber allowed the lethal anthrax aerosol to escape. Or another kind of accident might have caused the release. In his memoir, Russian defector Ken Alibek described an account told to him, namely, that by error a used filter was taken out but not replaced in the area where anthrax spores were being dried.\(^\text{15}\) The incentives for military scientists or workers with first-hand knowledge to come forward are minimal, since they might also be held accountable to the victims’ families for the epidemic.

The number of anthrax spores emitted from Compound 19 may have been as little as a gram, around a trillion spores.\(^\text{16}\) This small amount, dispersed over around five thousand people within the plume, indicates the extreme lethality of this agent and the irresponsibility of officials who allowed its close and hazardous proximity to civilians, as well as to unprotected soldiers and their families.

In July 1992, as part of a BWC voluntary confidence-building measure, Russia declared the Sverdlovsk facility (along with ones in Kirov and Zagorsk) as once engaged in Soviet offensive weapons activities. Sverdlovsk and Zagorsk in particular were noted as places where the feasibility of mass production of biological agents had been tested. “These enterprises had appropriate divisions: a section to produce culture media, a cultivating concentrating and purifying section, a sewage treatment plant, and other supporting technical services.” The declara-

\(^{15}\) Alibek’s account is second-hand, which probably accounts for its uneven quality. He asserts that the 1979 emission occurred the evening of Friday, 30 March, an impossibility, since the wind was then blowing in the opposite direction from Compound 19. He also describes the ceramics factory as being “across the street” from Compound 19, when it is 2.8 kilometers away, and mistakenly declares that all the night shift workers there that Friday “were dead within a week.” In July 1998, before Biohazard was published, I showed Alibek the summary of our research, published four years earlier in Science, which included the conclusive maps and wind data for 2 April 1979. But in his book Alibek ignored this research and even misstated the 2 April emission date: “Western scientists who have examined the data from the accident believe that it occurred on Tuesday, April 3, or Wednesday, April 4, because the first cases did not surface until two or three days after that, which would fit the usual incubation period for anthrax. These arguments suggest to me how well Soviet officials were able to manipulate information and conceal the truth.” See Biohazard. The Chilling True Story of the Largest Covert Biological Weapons Program in the World—Told From Inside by the Man Who Ran It, with Stephen Handelman (New York: Random House, 1999), 74.

tion specifically stated that no biological weapons stockpiles were ever created at these or any other Soviet facilities.\textsuperscript{17} Be that as it may, even small quantities of deadly agents were sufficient to create a high-risk scenario.

During the 1990s, exchange visits to other biological and military facilities were sponsored by the U.S. Nunn-Lugar Cooperative Threat Reduction program and other joint efforts. These on-site exchanges have informed the outside world about the large scale on which the Soviet Union could produce anthrax and other agents, and how dangerously capable it was of using them as weapons.

One reason the Soviets embarked on this illegal (and, in Sverdlovsk, self-destructive) investment has been suggested by Alibek and other former biological weapons scientists.\textsuperscript{18} The Soviet military believed that President Nixon’s 1969 renunciation of all offensive biological weapons was a sham, that the U.S., with its great scientific resources, especially in molecular biology and genetics, was moving forward with biological agents. Using declassified documents, former U.S. State Department official Raymond Gartoff has described how, in the early 1970s, an FBI double agent sought to persuade Soviet military intelligence that the U.S. had a secret offensive program.\textsuperscript{19} The specific impact this misguided ploy had on the Soviet biological weapons program is unknown. But in the cold war arms race, Soviet BW scientists, isolated from their colleagues at home and abroad and from society in general, lost their moral compass. Even though the BWC entered into force in 1975, one might say the same about those scientists who worked in the U.S. and U.K. offensive programs before 1969, when weapons for anthrax attacks on Soviet cities were developed and tested.\textsuperscript{20}

Throughout the 1980s, the United States in its annual Soviet non-compliance reports expressed its fear that the Soviet Union was concocting diabolical new biological agents. At least three former Soviet

\textsuperscript{17} “Form F” Russian Federation Biological Weapons Convention compliance statement submitted to the United Nations. Alibek has described Compound 19 as having researched antibiotic-resistant anthrax and glanders, having produced anthrax and glanders, and having stockpiled anthrax (\textit{Biohazard}, 298). The 1992 Russian declaration lists anthrax, tularemia, brucellosis, typhus, plague, Q fever, glanders, and other diseases.

\textsuperscript{18} Biohazard, 234.


\textsuperscript{20} See \textit{Anthrax}, 177, for descriptions of two U.S. programs. In one of them, the anthrax attack scenarios were tested with simulants aerosols on Minneapolis, St. Louis, and Winnipeg, as North American cities comparable to Soviet ones. U.S. Army “Munition Expenditure Panel, St. Jo Program,” \textit{Preliminary Discussion of Methods for Calculating Munition Expenditures, with Special Reference to the St. Jo Program} (Camp Detrick, Md., 1954).
BW scientists have confirmed that the Soviets did try to fabricate new pathogens, as if existing ones were not dangerous enough.\textsuperscript{21}

**Biological Weapons Investigation and Politics**

Our citizens’ inquiry into the 1979 Sverdlovsk epidemic was almost as rare as the outbreak itself. Historically, attacks using these lethal weapons almost never happen; Sverdlovsk itself was most likely caused by an industrial accident. Why biological weapons are rarely used is an important question, but a difficult one to answer. We can speculate that wind-directed weapons are tactically unwieldy, that human abhorrence of disease restricts its hostile use, or that relatively cheap, portable, and commonly available conventional weapons have an unrivaled capacity to target and destroy. Whatever the reasons, in war and in terrorist attacks, the use of both biological and chemical weapons has been unusual and is now universally banned. While even suspected cases of use should prompt inquiry, opportunities for independent investigation have been few.

Is there a special scientific and moral imperative to investigate disease outbreaks that may have biological weapons as their cause? Why, after all, did our team care about what happened in Sverdlovsk? In our world of heightened international mobility, any large epidemic evokes anxieties related to both self-preservation and empathy. The disease may be highly communicable, like smallpox; it may be exceptionally lethal, like the Ebola virus; or it may affect certain vulnerable populations, such as the elderly or children. Like other disease outbreaks, the use of biological weapons can carry any one or all of these threats, but with the difference that technology and human invention can greatly amplify the existing danger of bacteria, viruses, and parasites. The military development of biological weapons threatens all humanity, as Joshua Lederberg pointed out more than thirty years ago.\textsuperscript{22} When disease is the means to the ends of warfare, no one and no where is safe.

\textsuperscript{21}The first was Alexandr Pasechnik, former director of a weapons-related research facility in Leningrad, who defected to the West in 1990 and who is interviewed in M. Urban, *UK Eyes Alpha: Inside British Intelligence* (London: Faber and Faber, 1996). Ken Alibek defected in 1992. See also I. V. Domaradskiy’s 1995 memoir *Perevertysb* (Moscow, 2000) for descriptions of this scientist’s and others’ such work on potential biological weapons, particularly plague and tularemia. This memoir was translated into English in 2001 as *Troublemaker. The Story of an “Inconvenient Man”* (unpublished manuscript).

Thus, a scientific inquiry that clarifies the origin of a suspicious epidemic is the necessarily protective, humane reaction to the risk of biological weapons.

Still, political agendas and military secrecy are integral to all weapons issues and challenge the very idea of a scientific inquiry. The Soviet Union was not about to reveal its Sverdlovsk secret during the cold war. Other cases come to mind. Proof of the Iraqis’ investment in biological weapons had to be wrested from them by a United Nations team of investigators. Postwar political motives of the Japanese and the United States long obscured Japan’s brutal BW human subjects experiments with biological weapons and their 1937–45 use in China.

Political motives also drove the U.S. allegations of Soviet-implemented toxin attacks on Hmong refugees in Laos, the so-called “yellow rain.” In a parallel to the Sverdlovsk investigation, Matthew Meselson’s early 1980s team inquiry (in which I also participated) used field research, interview data, and laboratory analysis to determine whether the U.S. really had a case. Politically, this study’s conclusion was much different from that of the Sverdlovsk inquiry. Our “yellow rain” investigation disproved the Reagan administration’s claim that a deadly spray of trichothecene mycotoxins had been used on Hmong tribes in Laos. In fact, the claim was contradicted by U.S. data withheld from the public.

In line with the Reagan administration’s arms race agenda, the “yellow rain” allegation justified its decision to renew production of chemical weapons. Fortunately, that program was stalled by Congress and by the chemical industry itself, which was reluctant to cooperate. Later, in 1993, with the support of the Bush administration, an international ban on chemical weapons was signed in Paris, with more than 170 states now party to the agreement. The U.S. has yet to withdraw its allegations of Soviet trichothecene mycotoxin use, nor has it made public its uniformly negative laboratory tests for toxin in “yellow rain” samples.

To contend in public that the authority of science is higher than that of government can draw political fire. In response to Meselson’s

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26 In its 1992 BWC declaration, when Russia declared that the USSR had sustained an offensive program, it also noted that it had not considered trichothecene mycotoxins worth developing. That phrase, strangely enough, was deleted from the U.S. government translation of the Russian declaration into English.
independent research on “yellow rain,” for example, the Wall Street Journal ran a dozen editorials attacking his scientific standards and the propriety of his questioning the administration’s claim. Although our study of Sverdlovsk helped expose the Soviet coverup, some conservative critics refused to acknowledge the fact. As economist David Warsh succinctly described these reactions, “the conservatives simply will not take yes for an answer.”27

Nor has the old guard in the Russian military been satisfied with our science. In a recent Moscow newspaper article, the former head of the chemical and biological defense troops, General Stanislav Petrov, accused Meselson and his team of falsifying the Sverdlovsk map data, and blamed CIA sabotage for the 1979 outbreak.28

INDEPENDENT SCIENCE AND BW VERIFICATION

Scientific inquiry may lead to results that irritate or anger a government or ideological faction. Much more important is having the freedom to question and to embark on independent research. But how is such independence sustained? In pluralistic, liberal societies, a robust, autonomous science is supposed to stand apart from government. As Robert Merton reminds us, a strong scientific ethos—characterized by ideas of intellectual honesty, integrity, skepticism, disinterest, and impersonality—resists centralized state authority.29 At the other extreme, as Chandra Mukerji observes, U.S. scientists, many of whom depend on state resources, are pressured to legitimate whatever administration is in power, or risk becoming political outsiders.30

All cases, past and future, of alleged BWC treaty violations present a conflict between the humane mandate to clarify incidents, no matter what the political repercussions, and the science advisor’s ordinarily more passive role, that of judging facts generated by others. The independence of the Sverdlovsk investigation (and also the “yellow rain” study) relied squarely on academic personnel and university resources, and on funding from two private foundations (MacArthur and Carnegie) committed to arms control. Our emphasis was on scientific standards and methods, whether looking through a microscope or cross-

checking interview data. The broader community of science supported us and our reports. Our credibility was enhanced because we were not employed by any government. The methods and results of our Sverdlovsk investigation are widely cited for what they revealed about anthrax as a human disease and as a biological weapon, and also as a model for investigating other suspect outbreaks.\(^{31}\)

If biological weapons constitute a threat to humanity, the cause of suspected outbreaks must be conclusively investigated. Yet the Sverdlovsk inquiry had no organizational base. It and the “yellow rain” investigation relied on individual initiative (Meselson’s), a team of professionals drawn from different universities and institutes, and a considerable, unpredictable time investment, some of it in uncomfortable, even dangerous, places. Is there an institutional version of this approach that could meet the need in possible future cases?

No such organization now exists, although some models suggest strategies. The World Health Organization (WHO), for one, has enormous experience in team investigations of disease outbreaks, deploying physicians, anthropologists, and technicians to the field and coordinating its efforts with government agencies. But WHO, in order to preserve its global access, purposefully distances itself from politics, and has therefore avoided biological or chemical weapons controversies. One non-governmental organization, Médecins Sans Frontières, tracks disease outbreaks globally, but concerns itself more with patient treatment than with scientific evidence. In contrast, the Chemical Weapons Convention (CWC) employs a cadre of full-time verification experts. To date, they have conducted nearly a thousand routine inspections of declared chemical facilities, weapon stockpiles, and destruction sites. If necessary, the CWC can mount a short-notice, on-site challenge inspection of alleged treaty violations, although no state has yet requested one.\(^{32}\) The Biological Weapons Convention should have a comparable institutional base for facility inspection and for investigating suspected outbreaks or illegal attacks, but it remains largely a statement of norms, not an organization.

For want of alternatives, academic researchers remain best situated to do the independent applied science that characterized the Sverdlovsk investigation. Our academy and our tenure system are still the best protections for scholars who bring the scientific ethos to government issues. Nonetheless, a wide and coordinated array of institutional sup-

\(^{31}\)See, for example, *Biological Weapons. Limiting the Threat*, ed. J. Lederberg (Cambridge: MIT Press, 1999), in which the Sverdlovsk investigation is authoritatively cited in chaps. 3, 4, 5, and 6. The 2001 anthrax attacks reinforced the importance of the research.

\(^{32}\)The Iraqi gas attacks on Kurdish villages predate the 1993 CWC.
ports is necessary to the enterprise. One needs a university environ-
ment that rewards or at least tolerates potentially controversial inquiry,
funding sources committed to treaty verification, and professional orga-
nizations with national and international membership that also offer
respected forums for communicating research results.

As the cold war has receded, the younger generation of scientists
seems unconcerned about weapons of mass destruction and about
arms control, as does our society in general. In practice, the use of con-
ventional weapons still characterizes contemporary wars, just as con-
ventional explosives still characterize terrorist attacks. Contemporary
violent conflicts, with their emphasis on ethnic hatred and annihila-
tion, engage us more as ethicists or theologians than as scientists. We
once identified weapons of mass destruction as the primary indiscrimi-
nate threats to civilian lives. Now we recognize the vulnerability of
civilians in virtually all warfare.

Yet those whose careers are based in the life sciences should recog-
nize the unique threat of biological weapons, and the vigilance in the
name of humanity that they require. Potential bioterrorism is not at the
heart of this threat, though fear of it has generated new U.S. domestic
and military programs. Nor does the main threat of biological weap-
ons lie in any specific laboratory manipulation of a disease agent like
anthrax or smallpox. The main threat is the great onrush of biotech-
nology innovations that, if used for weapons development, would
expand the concept of harm to almost unimaginable dimensions.
Aimed at medical progress and driven by marketplace forces, some of
these innovations will deeply affect human physiology—how we repro-
duce, how we conduct our lives, even our neurology and how we
think.33 Recent history warns us that powerful science readily trans-
lates into highly destructive weapon systems. In the last century, chem-
istry was militarily exploited to develop mustard and nerve gases.
Physics was militarily exploited to develop nuclear weapons. The
temptation to direct remarkable new biotechnologies to military or
other hostile ends is certain to arise.

Every feasible restraint on biological weapons must be imposed to
avoid this temptation. Until now we have been relying on the interna-
tional norm represented by the Biological Weapons Convention. As we
saw in the case of the Soviet Union, the enemy of that norm is state
secrecy underwritten by an arms race. What we need now is a robust
international commitment to transparency, which would include rou-

33 M. Meselson, “Averting Hostile Exploitation of Biotechnology,” CBW Conventions
tine inspection of declared facilities, challenge inspections of suspected facilities, and rapid scientific investigation of suspicious disease outbreaks. We also need a system of effective rewards and penalties to encourage international compliance. Restraints should include an international criminal law to penalize individual malefactors, even former government officials.34

The new biological sciences may powerfully change our entire relationship to nature and perhaps change human nature itself. They must never be used against humanity. This imperative is no longer political, but a matter of protecting our species.