Critical Reviews in Microbiology, 32:47–64, 2006

ISSN: 1040-841X print / 1549-7828 online
DOI: 10.1080/10408410500496896

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The Anti-Plague System and the Soviet Biological Warfare Program

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The USSR possessed a unique national public health system that included an agency named "anti-plague system." Its mission was to protect the country from highly dangerous diseases of either natural or laboratory etiology. During the 1960s, the anti-plague system became the lead agency of a program to defend against biological warfare, codenamed Project 5. This responsibility grew and by the middle 1970s came to include undertaking tasks for the offensive biological warfare program, codenamed Ferment. This article describes the anti-plague system's activities relevant to both aspects of the Soviet Union's biological warfare program, offense and defense, and analyzes its contributions to each.

Keywords USSR; Soviet Union; Russia; Plague; Anti-Plague; Biological Warfare; Biological Weapon; Biodefense; Biosecurity; *Yersinia pestis*; Infectious Disease; Public Health

INTRODUCTION

In 1989, a Russian visitor to France unexpectedly presented himself at the embassy of the United Kingdom (U.K.) in Paris and requested asylum. A few hours later, after his identity had been checked and verified by British intelligence, he was flown to England and placed in a safe house where he spent several years being debriefed. Therefore, it was not until 1994 that he was publicly identified in a British newspaper as Dr. Vladimir Pasechnik and his story was told (Adams 1994). Many people outside the security community learned for the first time that for decades, the Soviet Union had supported the world's largest and most sophisticated offensive biological warfare (BW) program, codenamed *Ferment* (also known as Problem F).

Pasechnik was followed by other defectors from the Soviet BW program. Russian scientists who chose to remain in their home country also began to discuss their involvement in secret military programs (Domaradskij 1995; Alibek & Handelman 1999; Bozheyeva et al. 1999; Domaradskij & Orent 2003). However enlightening these testimonies, they have provided information only on the ostensibly civilian part of Soviet work with biological weapons. The larger and more important part of that program was operated in strict secrecy by the USSR Ministry of Defense (MOD) and remains unknown to outsiders, at least in the open literature. Further, what is known about the civilian part of the Soviet BW program, which was administered by an organization called Biopreparat, deals mostly with offensive research and development (see Table 1).

The Soviet Union did not limit itself to developing biological weapons to sicken and kill human beings. The USSR Ministry of Agriculture was responsible for a program codenamed *Ekology* that aimed to develop biological weapons against animals and plants (Rimmington 1999). Its work and accomplishments also remain hidden from outsiders in today's Russia. However, since this report addresses zoonotic and human diseases, *Ekology* will henceforth be mentioned only in passing.

Relatively less information has been published about how the Soviet Union sought to defend itself against enemy use of BW than how it sought to arm itself with biological weapons. This discrepancy is ironic because international law, as is explained below, allows governments to perform research, development, testing, and production that can be justified for defensive purposes. It would therefore appear that at least some of this defensive activity would have been described in the Soviet literature, but that was not the case (Koneva et al. 1974).[1] This report is the first published in the West that provides new information on the defensive aspect of the Soviet BW program. We are able to do so because as part of our investigation of the Soviet anti-plague (AP) system, a component of the USSR Ministry of Health (USSR MOH), we learned that in addition to its normal civilian functions, it was made responsible

Received 23 October 2005; accepted 17 November 2005.
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[1]The issue of the secrecy of work at AP facilities is discussed in Ouagrham-Gormley's article on the growth of the anti-plague system during the Soviet period. Here it is sufficient to note that some of the work published by AP scientists easily could fit within the "defensive" rubric, but was never identified as such in the Soviet literature. There is no question that AP scientists were able to publish some of their work.

TABLE 1
Major Soviet Offensive Biological Warfare Facilities in the 1980s

Ministry of Defense
Institute of Microbiology, Kirov, Kirovskaya *oblast*
Institute of Military Technical Problems, Sverdlovsk (now Ekaterinburg), Sverdlovsk *oblast*
Institute of Virology, Zagorsk (now Sergiyev Posad), Moscow region
Vozrozhdeniye (Rebirth) Island field test facility, Kazakhstan/Uzbekistan
Main Directorate "Biopreparat"
Institute of Molecular Biology "Vektor," Koltsovo, Novosibirsk region
Institute of Ultra-Pure Biopreparations, Leningrad (now Saint Petersburg)
Institute of Immunology, Lyubuchany, Moscow region
Institute of Applied Microbiology, Obolensk, Moscow region
Progress Scientific and Production Base, Stepnogorsk, Kazakhstan

for a program codenamed *Problem* 5, which was to defend the USSR from the biological threats posed by highly dangerous exotic pathogens whether their etiology was nature or laboratory.

It is necessary at the outset to make clear to readers that obtaining information on the role of the AP system in the Soviet BW program is difficult for two general and three specific reasons. The first general reason is that most information about the contributions of the AP system to either BW offense or defense is classified by the Russian government and cannot be accessed by persons without an appropriate clearance. Second, Russians are forbidden by law to reveal details of pre-1992 classified programs, with violations punishable by incarceration in prison (Supreme Court. . . 2002). This means that Russians in Russia usually are unwilling to talk to foreigners about pre-1992 secret events. (Although scientists working in the AP systems of newly independent states outside Russia are much less reticent to discuss their work in Soviet times, they also know less about the BW program.)

As to the three specific reasons, they have to do with the peculiarities of the Soviet administrative and bureaucratic systems. First, since the Soviet administrative system was highly compartmentalized, scientists working for one ministry or agency were hardly ever aware of what was being done in other ministries. As noted above, to this day most of the revelations about the Soviet BW program have come from scientists who worked for Biopreparat, such as Ken Alibek and Igor Domaradskij. Because of compartmentalization, these individuals would have little information about what was being done as part of the defensive effort, which resided mainly within the AP system. Second, to date no one from the Soviet MOD has spoken truthfully about the military BW program, including the role of the AP system in that program. For example, Anatoliy A. Vorobyev, a retired general who has written extensively on Soviet military medicine, hardly mentions the AP system (Vorobyev 2003). Similarly, no one from the USSR MOH who might be knowledgeable about the ministry's role in the Soviet BW program has yet come forward and spoken about it. Petr Burgasov, who held several important positions within the USSR MOH including Chief Sanitary Physician of the USSR, has written about some of the defensive work done by the AP system but without revealing any details about the larger role of the USSR MOH in the Soviet BW program (Burgasov 2000). Third, most and perhaps all directors of the AP institutes were kept in the dark about the overall Soviet BW program, especially its administration. Therefore, while they could impart information on what their institutes were doing as part of *Problem 5*, they had little or no knowledge of the overall reach of the defensive part of the Soviet BW program, and probably knew nothing about its offensive part.

While the AP system's main responsibility with regard to BW was defense, its role in the offensive part of the Soviet BW program, though minor, cannot be ignored. Accordingly, this article has four sections in addition to this introduction. First, the AP system's contributions to *Ferment* are described. Second, the same is done for *Problem 5*. Third, the implications of the 1972 Biological and Toxin Weapons Convention (BWC) for the Soviet BW program are discussed. Finally, in the conclusion, the contributions of the AP system to the Soviet BW program are analyzed.

I. THE ANTI-PLAGUE SYSTEM AND THE OFFENSIVE SOVIET BIOLOGICAL WARFARE PROGRAM

From its inception, the Soviet/Russian BW program has passed through two eras: the "classical" era (1928–1972) and the "modern" era (1973–1991); currently it is in third era, namely the "contraction and denial" era (1992 – present). As this report addresses Soviet history before 1992, it mainly covers the classic and modern eras.

A. The Classical Era

The Classical Era is so called because the USSR, like other nations that supported offensive BW programs during this time, used the "classic" microbiological techniques of mutation, selection, and propagation to weaponize pathogens such as *Bacillus anthracis*, *Francisella tularensis*, *Yersinia pestis*, and *Rickettsia prowazekii*, the causative agents of anthrax, tularemia, plague, and typhus, respectively.[2] With the advent of recombinant DNA

[2]Mutation comes from the Latin term *mutare,* meaning "to change." In the classical era, scientists could use X-rays, UV light, and chemicals to change the genetic material (DNA) of a microbe in order to alter its characteristics (phenotype). Mutated microbes that evidenced new characteristics of possible

research in the early 1970s, which made it possible to apply modern molecular biology techniques for both civilian and military purposes, the Classical era ended.

It is important for historical reasons to note that two large national offensive BW programs existed before World War II, those of the Japanese and Soviet governments. Then, during the war, the U.S. and U.K. governments established offensive BW programs, which by 1945 had become rather substantial. With the end of the war, the Japanese program disappeared, but the U.S., U.K., and Soviet programs continued and grew. The Soviet program benefited from the Red Army having captured some of the Japanese servicemen who had operated the Japanese BW program in Manchuria (USSR 1950; Soviet military scientist 2003). It is unknown, however, how exactly the Japanese expertise, experience, and know-how were utilized by Soviet weapon scientists.[3] Whereas the U.K. offensive BW program was closed down during the 1950s and the U.S. program in 1969, the Soviet program continued apace until 1992, but with a substantial increase in size and scope during 1972–1987 (see below).

Taking a step back in time, a secret decree issued in 1928 by the USSR Revolutionary Military Council ordered the beginning of an offensive BW research and development program (Bojtzov and Geissler 1999, 153–167). In accordance with this decree, the Military Chemical Agency, controlled by the Soviet People's Commissariat of Defense (which later became the MOD), was designated as the lead agency for managing both the offensive and defensive BW programs. Also, a civilian agency, the People's Health Commissariat (which later became the USSR MOH), was ordered to coordinate and execute military requests related to BW. At that time, the People's Health Commissariat[4] operated a biomedical research network consisting of at least 35 institutions working in disciplines such as epidemiology, genetics, immunology, microbiology, and virology (Bojtzov and Geissler 1999, 153–167). The importance of this development is that for the first time a national civilian agency whose mission supposedly was to maintain and increase the level of health of a population became directly involved in offensive BW. As far as we are aware, this type of development occurred in no other nations that had BW programs, all of which remained solely within the military realm. Further, the USSR MOH soon was to become the governing authority of the Soviet AP system, among whose responsibilities were to defend the nation against BW. Similar responsibilities in other nations usually belonged to civil defense agencies and the military, not to health agencies.

During World War II, German military intelligence agencies utilizing information derived from debriefings of Russian prisoners of war identified three Soviet institutes in the Moscow region that were suspected of involvement in offensive BW activities, including one AP institute, namely Mikrob (Barnes et al. 1951; Hirsch 1951). But other than being aware of Mikrob's existence, the lack of supporting German intelligence indicates that the Germans knew little or nothing about any involvement of the AP system in the offensive part of the Soviet BW program, both before and during World War II.[5] This lack of intelligence about Soviet BW efforts that faced the Germans during World War II applies to outsiders today. To date, very little information about Soviet BW efforts during and immediately after World War II has been published in the open literature (Bojtzov and Geissler 1999; Pasternak and Rubnikovich 1992).

B. The Modern Era

Two parallel developments took place in the early 1970s related to Soviet BW efforts. First, the Soviet government decided to sign the BWC in 1972, and to ratify the treaty in 1975. (The BWC is discussed further below.)

Second, in 1971–1972, the USSR Council of Ministers and the Central Committee of the Communist Party decided to substantially increase the size and scope of the existing Soviet BW program, which would undertake development, production, and testing projects that violated both the spirit and the letter of the BWC. To that end, they designated the 15th Main Directorate of the MOD (named Post Office Box A-1968 for reasons of secrecy) as the lead agency for all biological defense and offense activities. General Yefim I. Smirnov was selected to direct the 15th Main Directorate, which he did until 1985.[6] In parallel to the BW program carried out directly by the MOD, a second top secret BW program was established under the civilian cover of a vast pharmaceutical research and production complex known as Biopreparat, as well as under the ministries of agriculture and health. The AP system, which was part of the USSR MOH, was to play a role in the Soviet BW program.

As has been described elsewhere by Alibek, Domaradskij, Rimmington, and others, the scientific advances in the West that culminated in the early 1970s with the discovery of recombinant DNA technology stimulated the Soviet government to increase its own efforts in the field of modern biotechnology, including applications for military purposes (Alibek & Handelman 1999; Domaradskij and Orent 2003; Rimmington 1999, 2000). As mentioned above, two major offensive BW programs were instituted: *Ferment* and *Ekology*. *Ferment* was directed at solving problems related to weaponizing pathogens for use against

military interest were selected for further study. If studies of a mutated microbe indicated that it indeed held promise for military use, it was propagated by, for example, fermentation in order to produce a sufficient number so it could be field-tested.

[3]The U.S. also captured Japanese BW scientists and was able to extract much information from them (Harris 1994).

[4]The People's Health Commissariat, popularly known as *Narkomzdrav*, was renamed the Ministry of Health (*Minzdrav*) in 1942–1943.

[5]The German intelligence was wildly inaccurate as to identifying the location of Mikrob as being near Moscow; in actuality, Mikrob then as now is located in Saratov, approximately 750 kilometers (km) south of Moscow.

[6]As the commanding officer of the Main Military-Health Directorate of the Soviet Army, Smirnov headed the Soviet Army's medical service from 1939 to 1946, was USSR Minister of Health Care between 1947 and 1952, and then held various managing positions in the Red Army until being appointed commander of the 15th Directorate. He died in 1989.

humans, while *Ekology* was a program to develop biological weapons against animals and plants. While many of the institutions that implemented task orders under *Ferment* and *Ekology* were operating under the authority of Biopreparat, as well as civilian ministries such as the ministries of biotechnology industry, health, and agriculture, they actually were following the directives of the MOD's 15th Directorate. However, the majority of the scientists, engineers, and technicians who worked on tasks for *Ferment* and *Ekology* had, for reasons of secrecy, no knowledge of the overall programs and thus were unaware of the ultimate purpose of their labors. This situation resulted from the elaborate "legend" system set up by the Soviet government to shield every secret activity with a cover story that "explained" it as actually being done for a peaceful or defensive purpose. For example, if an outsider somehow learned about work with a pathogenic virus under *Ferment*, this activity would have a "legend" of defensive vaccine development.

As far as the AP system's role in *Ferment* is concerned, interviews with scientists who worked for Biopreparat reveal that *Problem 5* scientists (with the possible exception of some AP institute directors) were not informed about *Ferment*. Conversely, *Ferment* scientists within Biopreparat knew about *Problem 5* because it served as a "legend" for *Ferment*. If, for example, a civilian *oblast* official became curious about what research was being done at a local Biopreparat institute, he or she would be informed that it was of a defensive nature and therefore secret (Biopreparat scientist 2002). However, there was also a practical reason why Biopreparat institutes collaborated with AP institutes. These collaborative activities enabled Biopreparat to gain access to pathogens collected by AP scientists during field expeditions and to capitalize on research on highly dangerous pathogens at AP institutes. In particular, when AP researchers did basic studies on the pathogenicity of microorganisms recovered from the field, they were under orders to inform Biopreparat and the MOD about especially virulent strains. Thus, the AP system was a source of natural pathogens for Biopreparat and the MOD. AP institutes also studied the infectivity, virulence, and growth characteristics of many pathogens that were of interest to Biopreparat and the MOD. By having access to this information, the Biopreparat and MOD laboratories did not need to duplicate studies performed by AP scientists. In general, analysts at the MOD would monitor all research projects conducted at AP facilities and when they found something of interest, they would request the material they needed from the USSR MOH.

The MOD was not the only Soviet agency interested in the accomplishments of the AP system. Two former AP scientists have written a somewhat humorous account about the experience of a Rostov AP Institute scientist who was performing research on *Y. pestis* that employed genetic engineering technology. KGB operatives broke into his personal office safe and stole all of his handwritten notes on the research he was doing (Domaradskij and Suchkov 1996, 74).

The involvement of AP institutes in the offensive Soviet BW program was unequal. Anecdotal information suggests that two AP institutes (Mikrob and the Rostov AP Institute) were involved in the offensive BW program, but the nature of their contributions is unknown. From interviews with Biopreparat scientists we have learned that there were especially close collaborations between Biopreparat and the Volgograd AP Institute. As noted in the previous article, before becoming an AP institute, the Volgograd AP Institute had been a field AP station that was supervised by Mikrob. In 1971, a government decree made Volgograd a dedicated *Problem 5* facility (AP scientist 2002). Several years were needed, however, to implement the decree fully. One source claims that initially, the major responsibility of the Volgograd AP Institute was to develop biological detectors, but it appears to have been unsuccessful in this endeavor (Belousova 2001, 16–17). In any case, the Volgograd AP Institute was an oddity within the AP system from the outset because, unlike the other AP institutes, it had no natural disease foci to study and no subordinate field stations. Over time, however, the Volgograd AP Institute somehow built up a large culture collection of *Pseudomonas mallei* and *Pseudomonas pseudomallei* strains.[7] These bacteria are serious animal pathogens; *P. mallei* causes glanders (farcy) among equines, while *P. pseudomallei* causes melioidosis among several types of animals. These diseases are zoonotic, meaning that they can also infect humans. The culture collection at the Volgograd AP Institute was of particular interest to the BW program because these pathogens are infectious in aerosol form and, at that time, there were no vaccines to protect populations against them. Soviet scientists' knowledge about these pathogens during that period also was very poor.

Accordingly, beginning in 1983 and continuing until 1990, there was a strong collaboration between the Volgograd AP Institute and the Biopreparat institutes at Lyubuchany and Obolensk for the purpose of studying the pathogenesis of diseases caused by *P. mallei* and *P. pseudomallei*. In that collaboration, the Volgograd AP Institute provided the organisms, antigens, and antisera, and efficient methods for cultivating these organisms. Lyubuchany developed monoclonal antibodies against different antigens for the production of pure antigens and, in cooperation with Obolensk, studied the roles of different antigens in the immune response, as well as the pathogenicity and virulence of these organisms. Obolensk developed weaponized strains of these organisms, devised recipes for dry formulations of weaponized strains, and engaged in pilot production of weaponized strains (Biopreparat scientist 2003).

C. The Contraction and Denial Era

In 1987, General Secretary Mikhail S. Gorbachev approved a secret decree that ordered a gradual scaling back of the Soviet BW program. One result of this decree was that the USSR MOH

[7]Renamed *Burkholderia mallei* and *Burkholderia pseudomallei* in 1992. There are no natural foci for either of these pathogens in Russia, and diseases caused them to appear but rarely in the USSR/Russia.

decided to discontinue its involvement with offensive BW, which was done rather quickly. As far as is known, for the time being the AP system appears to have been minimally affected by this scale-back, remaining well supported until the dissolution of the USSR. Conversely, the offensive parts of the Soviet BW program began to decline; in particular, the Biopreparat institutions received diminished funding and had to cut back on their programs.

On April 19, 1992, Russian President Boris Yeltsin, who had replaced Mikhail Gorbachev in the Kremlin after the breakup of the USSR, acknowledged that the Soviet BW program had continued for some 20 years in violation of the BWC and ordered it to be closed down (Frolov 1992; Muratov et al. 1992). Accordingly, over the next several years, the various Biopreparat facilities were dismantled or converted to peaceful research and pharmaceutical production; the massive BW agents production facility in Stepnogorsk (Kazakhstan) was demolished.

It is unclear to what extent this development affected the MOD's biological facilities. There is no question that they were downsized, but we do not know to what extent. Then, as now, the Russian military biological institutes remain shrouded in secrecy, so it is unknown whether they currently are performing work that violates the BWC, serving as institutional memory banks for the achievements of the Soviet BW program, performing defensive research and development for the Russian military, or any combination of the above. Further, the Russian MOH has kept the AP facilities in Russia closed to outsiders, so very little is known about their recent activities. Conversely, the AP systems of the NIS outside Russia (with the exception of Turkmenistan) have for various reasons opened their facilities to outsiders, so we are in a good position to describe and analyze their activities and capabilities in a subsequent report.

Because political developments in Russia under President Vladimir Putin are outside the scope of this report, we note only that in recent years, representatives from the Russian Ministry of Foreign Affairs and MOD have demonstrated a regrettable tendency to repudiate earlier admissions by Yeltsin and others that the USSR once possessed an offensive BW program. A statement by Colonel Yevgeniy Pimenov, director of the MOD Institute of Microbiology in Kirov, is illuminative: "We have not produced any bacteriological weapons in the past and we are not doing so now. Our main purpose is to provide means of protection against dangerous bacteriological pathogens" (*Visit to the Russian* . . . 1991). Similar sentiments have been expressed by Burgasov (2000) and Vorobyev (2003). The current official Russian position at international forums, including BWC-related meetings, seems to be that the Soviet Union was involved only in developing defenses against BW and thus never violated the BWC.

II. THE AP SYSTEM AND THE DEFENSIVE PART OF THE SOVIET BIOLOGICAL WARFARE PROGRAM

Our search of the Russian language literature revealed that some writers had addressed the issue of defenses against BW during Soviet times, but when they did so, they almost invariably used Western sources to make a case for the USSR needing such defenses (Labezov 1957; Belikov 1960; Arkhangel'skiy et al. 1967; Myasnenko et al. 1983). The open Soviet literature contained little or no information on BW-related scientific research and development performed within the Soviet Union. It was not until after the USSR's dissolution that Russian authors began publishing accounts of what must have been a very large defensive effort to protect the USSR against BW (Litovkin 1999; Orlov 2000; Kholstov 2002). Yet, these publications make no note of the AP system and discuss only accomplishments by the military. Similarly, there is no mention of *Problem 5* or defenses against BW in the five volumes we have seen of the monumental twelve-volume set edited by M.I. Levy that meticulously recounts the history and accomplishments of the AP system during the Soviet era.[8] In the final analysis, as far as we are aware, Dr. Igor Domaradskij is the only author known in the West who, to some extent, has addressed the general subject of the AP system and its role in the Soviet defensive BW program.

Domaradskij is well qualified for the task, having been director of two AP institutes (the Irkutsk AP Institute from 1957 to 1964, and the Rostov AP Institute from 1964 to 1973) and, subsequently, an important official in the Biopreparat system (see Appendix 1). He probably was the first to introduce Western readers to the term *Problem 5* and to explain that it was a cover name for the USSR's defensive BW effort (Domaradskij 1995). Because Domaradskij was transferred from the AP system to Biopreparat in 1972, his knowledge about the work done under *Problem 5* in the 1980s probably is incomplete. Since Domaradskij first mentioned *Problem 5* in 1995, other authors have also referred to it in their works, but none has dealt with it in depth (Alibek and Handelman 1999; Belousova 2001, 16–17). While there is yet much to be learned about *Problem 5* activities and accomplishments, this article begins the process of filling in the information gaps about Soviet defensive BW activities. Because of the lack of open source information on Soviet defensive efforts before 1970, the final part of the Classic era and the Modern era are emphasized.

Of course, it is reasonable to assume that the USSR had a well-organized defensive BW program before *Problem 5* was formally established; after all, offensive activities that commenced in 1928 must have had a defensive counterpart if for no other reason than to protect Red Army soldiers from accidental exposure to their own weapons. In his memoirs, Burgasov (2000) describes some of the defensive work done during and after World War II, on which he reported regularly to Beria[9] and

[8]See Ouagrham-Gormley's article on the growth of the anti-plague system during the Soviet period for references to M.I. Levy. The 12 volumes of which he is the editor had limited printing and are not available outside Russia. Of these 12 volumes, we have been able to secure five.

[9]Lavrenti Pavlovich Beria (1899–1953), the KGB chief under Stalin, was notorious for ruthless persecution of political opponents and one of the main organizers of the massive repression campaign in the late 1930s (the Great Purge).

sometimes to Stalin.[10] From Burgasov's memoirs it appears that responsibility for defenses against biological weapons resided solely with the military. We cannot be certain of his information, however, because Burgasov reveals no details about pre-*Problem 5* defensive activities.

Most readers who have seen the term *Problem 5* probably believe it to be a unique codeword, much like *Ferment* and *Ekology*. In fact, the term *Problem 5* was derived from the establishment of five "problem commissions" in the 1950s and 1960s to solve health-related problems generated by plague and, later, cholera and exotic diseases and pathogens. Be it as it may, several sources indicate that Mikrob started conducting research related to the defensive BW program in the 1950s, which is several years before *Problem 5* was formally created.

Sometime in the mid to late 1950s, the idea of setting up a special commission on plague was raised within the USSR MOH. It came about as a result of field research indicating that some regions in the USSR possessed natural plague foci[11] and that the disease could emerge from these foci and afflict nearby human populations. As noted in Melikishvili's article on the genesis of the anti-plague system during the Tsarsist era, in the early twentieth century Russian scientists believed that all human plague cases that occurred in the USSR had in one way or another been imported from nations such as Afghanistan, China, and Mongolia. Once the concept of natural plague foci was understood, two special commissions called "Problem Commissions" were established as a joint endeavor between the USSR MOH's Scientific Council and the USSR Academy of Medical Sciences. A third Problem Commission was set up shortly thereafter, and a fourth and fifth Problem Commissions followed in the 1960s. The USSR MOH's 2nd Directorate would issue a decree annually that specified the membership of each problem commission, its research objectives, and the agenda of its annual meeting. This practice continued until the USSR's dissolution.[12] The responsibilities of these five commissions were as follows (CNS 2003b; AP scientist 2003):

- The First Problem Commission (*Problem 1*) guided studies of known natural plague foci and investigated whether other, unknown natural foci existed in the USSR. The *Problem 1* research agenda also included studies of hosts and vectors that carried and transmitted plague bacteria, diseases that afflicted the plague hosts, and decontamination methods. To accomplish this ambitious research agenda, numerous regional and field AP stations were set up in regions in which natural plague foci existed. The First Problem Commission met annually at Mikrob.
- The Second Problem Commission (*Problem 2*) was established simultaneously with the First. Its objective was to eliminate plague and natural plague foci. Under *Problem 2*, studies were done on strains to clarify their biochemical and other properties and antibiotic sensitivity patterns. In addition, practical methods were developed to improve diagnostic techniques (especially serological techniques), seek out and test avirulent strains for possible use in vaccines, and improve therapeutic approaches for curing plague. Some activities under *Problem 2* were directed at developing methods for killing rodents that were hosts to *Y. pestis* or the parasites they carried. Members of this commission also met annually at Mikrob.
- The Third Problem Commission (*Problem 3*) was responsible for promoting the manufacturing of the various types of diagnostics and laboratory procedures needed to fight highly dangerous pathogens, with a concentration on plague and cholera. *Problem 3* supported work to manufacture and test bacteriophages (viruses that infect bacteria) for diagnostic purposes, to improve serological (antibody) diagnostic techniques, and so forth. This commission also met annually at Mikrob.
- The Fourth Problem Commission (*Problem 4*) was established in the aftermath of a large outbreak of cholera in Uzbekistan in 1965 and focused exclusively on this disease.[13] Since cholera commonly was thought of as a disease afflicting developing nations, the USSR was loath to admit it that it suffered from this problem and thus did not report any of the cholera outbreaks that occurred on its territory in the 1960s and 1970s to the World Health Organization (WHO). Accordingly, all work related to *Problem 4* was classified, and few scientists within the AP system beyond those who actually worked on cholera problems knew about it. The USSR MOH appointed the Rostov AP Institute as the lead institute for *Problem 4*. This meant that all AP stations and institutes had to report directly to Rostov AP Institute on their work related to cholera. Further, the Fourth Problem Commission met annually at the Rostov AP Institute.
- The Fifth Problem Commission (*Problem 5*) was responsible for what Domaradskij termed "the antibacterial protection of the population," (Domaradskij and Orent 2003) including defenses against biological weapons possessed by foreign countries. This commission operated continuously out of the N.F. Gamaleya Institute of Epidemiology and Microbiology in Moscow (hereafter Gamaleya). All research related to *Problem 5* was classified Top Secret and could only

[10]Joseph Stalin (baptized Iosif Vissarionovich Dzhugashvili in 1879) was Secretary General of the Communist Party's Central Committee from 1922 until his death in 1953. As such, he was the *de facto* dictator of the USSR.

[11]A natural disease focus is an area or region to which a particular disease is endemic—see Appendix 2.

[12]As will be noted in our next Occasional Paper, the problem commissions have been resurrected by the Russian government.

[13]This outbreak probably was part of the 7th pandemic of cholera that ravaged the world between 1965 and 1970.

be done at specially designated and protected institutes and laboratories. Within the AP system, only AP institute directors and specially designated scientists knew about the existence of *Problem 5*, and most AP scientists were unaware of it.

Problem 5 initially involved three tasks. First, it supported practical work within the USSR that focused on highly dangerous diseases other than plague that were endemic to the country, and the response of hosts to the causative pathogens. Second, it was responsible for protecting the USSR from exotic diseases that might be imported. Third, it was responsible for developing safety measures that could be applied to defend against BW and to manage the consequences of a successful attack. Activities under the third task consisted mainly of developing detection methods for agents that might be used in such attacks and suitable therapeutics. This work included, for example, laboratory studies of the immunological responses of various hosts to different pathogens, investigations of means whereby pathogens disperse or spread, and animal studies to model the spread of communicable diseases. For reasons discussed below, activities under the third task were to increase substantially in the mid 1970s.

The organizational structure of *Problem 5* was straightforward. The MOD decided what work needed to be done under *Problem 5* and issued the required task orders to the USSR MOH 2nd Directorate, which forwarded them to the *Problem 5* Commission headquartered at Gamaleya. The commission then determined which laboratories were best suited to fulfill these tasks and issued them the requisite orders. Each task was given a codename, usually of an animal or an object, such as "butterfly" or "lamp." Indeed, "Lamp" was the actual codename of a project the objective of which was to develop a new broad spectrum antibiotic. If the completion of a task required the collaboration of several laboratories, the sub-tasks would be named Lamp-1, Lamp-2, and so on. Further, as noted in Ouagrham-Gormley's article on the growth of the anti-plague system during the Soviet period, all microorganisms were given code numbers. The *Problem 5* coding system was exacting in that each code number represented a specific pathogen. This system was time-consuming for institute directors to use; sometimes they had to spend hours translating secret tasking orders into language understandable to non-*Problem 5* scientists and, when the task had been completed, they would have to devote more time to translating the results into the secret terminology used to report back to the MOH. This procedure was necessary because most scientists who actually carried out *Problem 5* tasks and sub-tasks were unaware that in so doing, they were part of the Soviet BW defense effort.[14]

As mentioned above, the lead scientific institute for *Problem 5* was Gamaleya, although the D.I. Ivanovskiy Institute of Virology (hereafter Ivanovskiy) and the Scientific Research Institute of Poliomyelitis and Viral Encephalitis (now called the M.P. Chumakov Institute of Poliomyelitis and Viral Encephalitis—hereafter Chumakov), all in Moscow, also had important functions (see below). As explained by a knowledgeable AP scientist, Gamaleya played a key role because it housed the Central Commission on *Problem 5* (AP scientist 1999). Each year, the Central Commission contacted the directors of the AP institutes to request reports on their *Problem 5* activities, and it also reviewed all plans of particular issues within the framework of *Problem 5*. In addition, every year or every other year, the Central Commission members, including representatives from the 2nd Directorate of the USSR MOH and from MOD, would pay visits to all of the institutes involved in *Problem 5* tasks.

After a *Problem 5* task had been completed by a designated laboratory or institute, the staff members of one of the three lead scientific institutes—Gamaleya, Ivanovskiy, or Chumakov—reviewed the completed work to determine whether objectives had been achieved and the procedures were adequate and appropriate. The division of labor among the three institutes was as follows: Gamaleya reviewed the draft reports related to work involving bacteria, some rare viruses, epidemiology, vaccine production, and diagnostics; Ivanovskiy reviewed work related to the biochemistry and molecular biology of viruses; and Chumakov addressed work related to polioviruses, polio vaccines, and tropical viruses. Critiqued draft reports were sent back to the executing institute or laboratory for revision and the final report was transmitted to the MOD via the USSR MOH. If the reviewing institute found a draft report to be seriously deficient, either the task had to be redone or a satisfactory explanation had to be provided by the executing institute as to why the task could not be accomplished.

As mentioned above, the USSR MOH's 2nd Directorate directed all *Problem 5* work performed by the AP system. From this point of view, *Problem 5* could be considered a civilian program. However, Ken Alibek, who otherwise barely mentions the AP system in his book about the Soviet BW program, identifies Major General Vladimir Serebryakov as its head (Alibek & Handelman 1999). Conversely, another of our sources named Major General Victor N. Pautov as having headed *Problem 5* while headquartered at Gamaleya (AP scientist 1999). It is of course conceivable that both headed the program at different times. The important point is that generals headed *Problem 5*, strongly suggesting that it was primarily a military program but was executed at civilian institutes.

As mentioned above, Domaradskij asserts that the *Problem 5* Commission was established in the 1950s. Another source claims it was founded in the 1970s.[15] In any event, it appears that the commission's responsibilities were considerably expanded

[14]By far most of the scientists we have interviewed had never heard of *Problem 5*.

[15]Since *Problem 4* was set up in the middle 1960s, it would appear as if *Problem 5* would have been set up later. It could be that defensive BW activities were performed by *Problems* 1, 2, or 3 in the 1950s, and then given a special status as *Problem 5* later on.

sometime between 1975 and 1976, shortly after the International Olympic Committee awarded the 1980 Olympic Games to Moscow. At that time, Soviet officials began worrying that foreign visitors might import exotic diseases. This problem was discussed in 1976 by a high-level interagency group with representation from the MOD, KGB, Ministry of Science and Technology, MOH, and Academy of Medical Sciences. Concluding that the threat of disease importation was real, the group ordered the USSR MOH to prepare technologies for the detection of exotic pathogens, diagnostics for exotic diseases, and therapies for treating them. Accordingly, in 1977 the major secret activity of the *Problem 5* Commission was to select institutes that would be capable of undertaking these new tasks, conduct background checks of the people who would do the work, and establish lines of authority and reporting. In 1978, the implementation of the new set of tasks under *Problem 5* began. For example, one institute was tasked with preparing defenses against all exotic viruses that visitors might bring with them, including Lassa, Ebola, and Marburg hemorrhagic fever viruses. Vials containing strains of these very dangerous viruses, obtained from a culture collection at Chumakov, were conveyed to the institute in charge of this task under conditions of high security. Two persons guarded the samples at all times, only train travel was permitted, the samples were specially packed in padded metal containers, and the guards had to check in with the USSR MOH at several predesignated points along the route. The strains of Lassa, Ebola, and Marburg were then used to develop detection, diagnostic, and therapeutic methods for these diseases. The results of this work were reported to Dr. Vladimir Sergeyev,[16] at that time the head of the committee on biosafety issues and arenaviruses in the Department of Quarantine Infections of the USSR MOH (Problem 5 scientist 2003).

The Soviet Union did not experience any unusual disease outbreaks during and immediately after the 1980 Olympics. It is not known, however, whether no new pathogens were introduced either accidentally or deliberately into the USSR by foreign visitors, or if some pathogens were in fact introduced but were defeated by defenses developed under *Problem 5.*

As with the offensive part of the Soviet BW program, *Problem 5* not only had entire closed institutes dedicated to it but also dedicated laboratories within otherwise open institutes. In effect, all AP institutes were *Problem 5* institutes because they were assigned *Problem 5* tasks. The AP institutes' level of participation in *Problem 5* was, however, unequal, and Mikrob, the Rostov AP Institute, and the Volgograd AP Institute had the heaviest involvement. As noted in Ouagrham-Gormley's article on the growth of the anti-plague system during the Soviet period, Mikrob started working on BW-related projects as early as the 1950s, when it was tasked with developing fast detection methods for *Y. pestis*, antibiotic testing, and developing new treatment methods for plague, among other assignments. In the early 1960s, the Rostov AP Institute was redirected to work on *Problem 5* and was scheduled to study vaccines, immune resistance, and lung disease mechanisms in animals. More remarkably, for some time the Rostov AP Institute was slated to become a BW test site. Had this plan materialized, a unique military-purpose facility would have been placed within a civilian institute (Domaradskij 1995). In 1965, the Soviet MOH reached an agreement with the Chirana Medical Equipment Plant, a Czech company located in Brno, for the latter to design and build an aerosol test chamber at the Rostov AP Institute, and to provide all equipment required to operate the chamber. Although the Czech company worked on this project until 1969, the USSR MOH terminated the agreement because of its high cost (Domaradskij & Orent 2003).

As explained above, before becoming mainly a *Ferment* institution, the Volgograd AP Institute was a *Problem 5* institute. The Rostov AP Institute was appointed as the lead AP institute for *Problem 5* sometime during 1964–1965.[17] The Almaty AP Institute had a scientific team working on *Problem 5* tasks but was involved in defensive efforts to a lesser extent than either Mikrob or the Rostov AP Institute. The Almaty institute's contribution to the offensive BW program (*Ferment*) is unknown. After Biopreparat was established, two of its institutes, Lyubuchany and Obolensk, had collaborations under *Problem 5* with Mikrob and the Rostov AP Institute, but had no relationship at all with the Stavropol, Irkutsk, and Almaty AP Institutes (Biopreparat scientist 2003). In general, the Irkutsk AP Institute and the Stavropol AP Institute appear to have devoted only a small portion of their activities to BW-related activities (AP scientist 2002 and 2003).

Although all AP institutes had for some time been involved in anthrax work, only the Volgograd AP Institute and the Stavropol AP Institute initially studied anthrax for *Problem 5*. But eventually all did this work for *Problem 5*. Mikrob had another priority area within *Problem 5*, which Rostov AP Institute also shared later on, namely developing antibiotic prophylaxis and therapy along with new treatment options for various kinds of plague.[18]

The Almaty AP Institute has not been identified as being involved in defensive efforts by either the USSR government or Biopreparat scientists, but in fact it undertook *Problem 5* tasks. For example, Almaty AP Institute specialists carried out studies of the immunogenicity, reactogenicity, and safety of vaccine strains of plague and brucellosis bacteria. With respect to brucellosis, they made a comparative study of the immunogenicity and residual virulence of brucellosis vaccines 19, 19BA, and 104M, when administered topically or subcutaneously (CNS 2003b). Almaty AP Institute scientists also sought to improve on a live plague vaccine that utilized the *Y. pestis* EV strain (Mishankin &

[16] In 1988, Petr Burgasov, Vladimir Nikiforov, and Vladimir Sergeyev visited the U.S. on the invitation of Professor Matthew Meselson of Harvard University and made presentations "proving" that an anthrax outbreak in 1979 in Sverdlovsk had a natural origin. As of this writing, Sergeyev is the director of the Martsinov Institute of Medical Parasitology and Tropical Medicine in Russia.

[17] As pointed out above, the Rostov AP Institute also was the lead institute for *Problem 4* (the study of cholera).

[18] There are three types of plague; bubonic, pneumonic, and septicemic. Each type presents differing problems as to diagnosis and treatment.

Lopatina 1996, 3–9).[19] To this end, L.I. Leshkovich did experimental research to develop the *Y. pestis* 100P6 strain for vaccine use. In the 1960s and 1970s, Dr. M.F. Shmuter developed the *Y. pestis* K-1 strain, which had earlier been isolated from the Kyzylkum plague natural focus. After many years of laboratory research on animals, he proposed the K-1 strain for advanced vaccine development. After verification by a government commission, the K-1 strain was approved for serial production, superseding the EV vaccine strain. However, one year after the introduction of the K-1 strain, it was taken out of production because of its unacceptably high level of side effects, and the EV vaccine strain was reintroduced. All this work to develop an improved plague vaccine was done secretly under *Problem 5*.[20]

Apart from AP facilities, many open medical and public health institutes (i.e., institutes whose scientists were relatively free to publish in international journals and receive foreign visitors) were ordered to take on *Problem 5* tasks. For this purpose, the institutes had between one and three closed laboratories that no one could enter without proper clearance (Problem 5 scientist 2003).

The Soviet Union generally did not adequately support bioscientific research in the civilian sphere except at a few politically-favored institutes (Zilinskas 1984; 610–615, 686–692). Conversely, *Problem 5* institutes and laboratories were well supported. For example, the *Problem 5* task codenamed Lamp had as one of its objectives the testing of all antibiotics commonly available in Western countries for possible use against various bacterial pathogens of BW interest. In order to enable the implementing institute to accomplish this extremely ambitious task, it was provided with samples of antibiotics that had somehow been procured from countries all over the world, as well as those used in the USSR. The institute's director also was given the authority to assign his top scientists to undertake the rather long and arduous process of testing all of these antibiotics against all Group 1 and Group 2 pathogenic bacteria. Another *Problem 5* task that was undertaken for approximately the same purpose involved the evaluation of foreign anti-viral compounds and vaccines. As can be imagined, it was expensive to accomplish these tasks, but the required funding appears to have been provided to the executing institute without major problems (Problem 5 scientist 2003).

According to our sources, all *Problem 5* institutes and laboratories were well secured in Soviet times. They all had powerful so-called "first departments" staffed with KGB agents, perimeters guarded by troops from the Ministry of Interior, and often had direct lines of communications with nearby police stations. The more important *Problem 5* facilities were surrounded by high concrete walls topped with broken glass or barbed wire; had closely controlled entry gates operated by troops; and usually had television cameras for monitoring the movement of people near the facility and motion detectors on windows and doors to detect unauthorized entry. In addition, the Soviet Union had in place strict regulations on the storage and transport of pathogens, which will be described in a subsequent report. These security measures extended beyond the AP facilities themselves. The KGB maintained a presence in the communities in which the institutes were located and thus could check on and control any activity that might be directed at compromising the security of these facilities.

It is worth mentioning one legacy of the Soviet AP system. In the 1960s, Gamaleya started to collect articles and reports generated in the course of Problem 5 research and development and to assemble them in bound volumes. According to a trustworthy AP scientist, this collection on biodefense work (*raboty po biozashchite*) eventually encompassed more than 30 volumes (AP scientist 1999). These volumes included studies on decontamination, treatment, prevention, development of vaccines, indications of diseases, methods of treating infections, original data on pathogenesis, and epidemiological issues. Some of these publications contained information that was readily available in the open literature, some were designated "For Official Use Only," and some were classified. Because all of the volumes bore a Top Secret (*sovershenno sekretno*) stamp on their binders, only persons with the Top Secret clearance could access them at the Gamaleya library.

In the mid-1990s, Professor Yu. G. Suchkov wanted to declassify parts of the contents of the volumes, such as those parts dealing with methods of decontamination. Despite the fact that Suchkov had worked for many years at Gamaleya, rising in rank from scientist to director, he was denied permission to declassify the collection because of objections raised by the aforementioned General Pautov (AP scientist 1999). (General Pautov, described by the AP scientists as a very cautious man, later was appointed to direct the Institute of Experimental Hygiene in Kirov.) This situation apparently persists today, although Gamaleya receives international funding and its work is supposed to be transparent.

Before concluding this section on biological defense, it is important to discuss another entity that supplemented *Problem 5*, namely the "specialized epidemic control teams" (SPECTs). In 1963, after Domaradskij was appointed director of the Rostov AP Institute, he claims to have created SPECTs to combat highly

[19]Originally, Mikrob procured the *Y. pestis* EV vaccine strain from the Pasteur Institute in 1936. By the late 1930s, it had become the basis of the plague vaccine used throughout the USSR; it still is the basis for the currently used EV NIIEG (Epidemiology and Hygiene Scientific Research Institute) vaccine. However, it had certain drawbacks; for example, the strain was poorly characterized, its use resulted in excessive adverse reactions in some recipients, and the vaccine exhibited highly variable responses between individuals. Therefore, Soviet plague researchers were forever trying to develop better plague vaccines.

[20]Vaccine research and development in the USSR present an odd dichotomy as to secrecy. Work done under *Problem 5* on vaccines was classified, so its results were not openly published. However, much work on, for example, plague vaccines done at AP institutes was open and its results published. It might be that work to investigate and improve known vaccine strains, such as EV, was permitted to be done openly, while research on new or unique strains was kept secret.

dangerous infections. He writes:

> . . . as originally planned by the Soviet Ministry of Health (in 1964), [SPECTs] were mobile nonmilitary civil defense formations mainly intended for wartime, which originally confined their range of duties to the specific indication of biological weapons. These SPECTs were set up as little institutes that could be deployed very quickly wherever they were needed. They had everything required for microbiological diagnostics and they were suitable for peacetime outbreaks as well as during wartime (Domaradskij & Orent 2003).

More information about SPECTs is contained in a report that was commissioned specifically for this study (CNS 2003a). According to this report, SPECTs were set up in the Georgian SSR in response to an order given in the early 1970s by the director of the Georgian regional AP station. The report notes that even before SPECTs came into existence, the bacteriologists and epidemiologists of the AP system had to take annual courses and seminars on BW "indicators." The new SPECTs included skilled professionals who, in case of a bacteriological attack, could set up a laboratory in a few hours at any location, identify the causative pathogen, demarcate the infected site, organize anti-epidemic work, and eliminate the disease. All new field epidemiological methods underwent practical testing during the annual training of SPECTs in Georgia. Later these teams played an important role in containing cholera outbreaks in Tbilisi, Rustavi, and Batumi in the 1970s and in managing the consequences of the 1988 Spitak earthquake in Armenia.

Each SPECT team would consist of about 20 persons, organized as follows:

- Reception and registration of samples—one doctor and one laboratory assistant
- Sample sorting group—one doctor and two laboratory assistants
- Fluorescence microscopy group—one doctor and one laboratory assistant
- Serology group—one doctor and one or two laboratory assistants
- Inoculation group—one doctor, 2 two laboratory assistants, and one laboratory attendant
- Infection and dissection group—one doctor and one laboratory assistant
- Virology group—one doctor and two laboratory assistants
- Technical support group—one each of electrician, plumber, and autoclave technician

Were a suspicious disease outbreak to be detected, an investigation would ideally commence within two to three hours. When a SPECT arrived at the site of the occurrence, team members first would conduct an initial evaluation of the site, looking for non-specific indications that a biological attack had taken place, such as sick animals. Air-sampling devices (impingers) would then be deployed at various locations throughout the suspected site and the wind direction and speed recorded. Team members would seek out witnesses and sick persons, if any. Samples would be collected from munition remnants, plants, soil, and standing water. If there was suspicion that insects had been used to deliver a pathogen, insects at or near the site would be collected. A map of the suspected site would be prepared and used to record pertinent meteorological data such as wind direction and speed, humidity level, and climatic conditions, as well as sites where samples had been collected. Samples from the impingers and the environment, as well as the site map, would then be conveyed to a reference laboratory, which would attempt to isolate and identify possible pathogens.

The reference laboratory would test for bacteria, viruses, fungi, and toxins. For bacteria and fungi, a portion of each sample would be inoculated onto various nutrient media and checked for growth every six hours. Portions of each sample with added reagents (inoculum) would be injected into test animals. For example, to test for botulinum toxin, the inoculum would consist of 1 ml of sample plus 0.4 ml of polyvalent botulinum serum; if testing for rickettsia and chlamydia, the inoculum would consist of sample plus anti-botulism serum, penicillin, and streptomycin; for viruses, the inoculum would be sample plus penicillin and streptomycin; and for mycosis, the inoculum would be sample plus penicillin, streptomycin, and chlortetracycline. After 18 to 20 hours, half of the test animals would be killed and tested for bacterial, viral, or fungal pathogens, or toxins. For example, samples taken from spleens would be used to make smears that were stained for fluorescence microscopy examination, and liquid suspensions would be prepared for direct microscopic identification of fungi. Approximately 18 hours later, the remaining test animals would be killed and tested in the same way. A SPECT team using these procedures would be expected to process 20 samples and obtain preliminary results in about 6 hours and final results within 48 hours.

Procedures used by the SPECTs might appear outdated from today's perspective, especially their reliance on the inoculation of test animals and the lack of sensitive detection technologies commonly available in the West, such as the enzyme-linked immunosorbent assay (ELISA). However, it is worth noting that teams from AP institutes and stations had been investigating natural disease foci for many years with a high degree of success and safety, using classical methods that had been honed to perfection over time. Within the context of the pre-1992 Soviet system, SPECTs probably would have performed a more than adequate job when faced with the challenges of a biological event of unknown origin because their procedures, although outdated by Western standards, worked well in the experienced and practiced hands of AP scientists and technicians. Moreover, officials in the totalitarian Soviet state were able to impose draconian quarantine measures on short notice with the knowledge they would be obeyed. For these reasons, outbreaks of infectious diseases in the USSR were usually contained rapidly, as exemplified by the management of a smallpox outbreak that occurred in 1971 in Aralsk, Kazakh SSR (Tucker & Zilinskas 2002).

Of course, SPECTs were set up not only in Georgia but also throughout the AP system. Before the mid-1960s, whenever

disease outbreaks occurred, the USSR MOH would order specialists from the AP stations close to the site of the occurrence to deal with the epidemic. However, after a large outbreak of cholera took place in Uzbekistan in 1965, the USSR MOH decided to create SPECTs units at each of the six AP institutes and at some AP stations to mobilize specialists and needed equipment whenever it was required to deal with an outbreak. Thus, almost every AP station in Kazakhstan created its own SPECT in the 1970s, and similar developments took place in the other Soviet republics. In each case, the specialists constituting a SPECT were trained at the AP station or institute where the team was based. Further, every year the Soviet AP system conducted so-called "all-union" (involving all of the USSR) field training exercises for members of SPECTs. The locations for such training exercises were different every year; one year it was held at the Irkutsk AP Institute, another year at Mikrob, the next year at the Rostov AP Institute, and so on.

Despite the existence of the extensive AP system and the SPECTs, it appears that in the early 1980s the Soviet government concluded that these resources were inadequate for assuring the country's biological security. This conclusion can be inferred from the fact that in 1982, a secret decree signed by General Secretary of the Communist Party Leonid Brezhnev established yet another security service for the specific purpose of counteracting "massive infections from biological weapons used by the enemy" (Belousova 2001, 16–17). According to our source on this development, the agencies that were to fund this new entity, Gosplan and the Ministry of Finance, balked at doing so because "there were too many directives and not enough money." Therefore, the new service only existed on paper until the dissolution of the Soviet Union.

III. THE BIOLOGICAL AND TOXIN WEAPONS CONVENTION AND THE SOVIET BW PROGRAM

An important political development took place on April 10, 1972, that was to have implications for both the offensive and defensive parts of the Soviet BW program. On this date, the Soviet Union, along with 77 other nations (including the United States), signed the BWC (USACDA 1996). In doing so, the signatories conveyed their solemn intent to observe a complete ban on the development, production, stockpiling, and transfer of "microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes; [and on] weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict" (Article 1). The BWC also specifies that each signatory nation, upon ratifying the treaty, "undertakes to destroy, or to divert to peaceful purposes, as soon as possible but not later than nine months after entry into force of the Convention, all agents, toxins, weapons, equipment and means of delivery specified in Article 1 of the Convention, which are in its possession or under its jurisdiction or control" (Article 2).

As noted above, at about the same time that the Politburo decided to sign the BWC, it ordered the MOD to substantially expand and modernize the offensive BW program. Further, Moscow made certain that this expansion would be conducted secretly and in such a way that no outsider would be likely to discover its existence, which would be a major violation of the BWC.

In 1975, the Soviet government ratified the BWC, thus becoming a full-fledged state party to the treaty. On June 24, 1975, when the Soviet representative announced to the UN disarmament conference that his country had ratified the BWC, he declared that the USSR had never possessed an offensive BW program and therefore had no stockpiles of weapons to destroy (USA denounced . . . 1980). This statement was echoed by an article in an influential Soviet journal that could not have been published without the government's concurrence (Gardov 1980, 108–115). However, we now know that even as Soviet officials denied the existence of the BW program, the USSR was continuing to expand and enhance it in direct contravention of the treaty.

The BWC's Article 12 specifies that state parties are to convene a review conference five years after the treaty's entry into force to assess its operation. Thus, the first review conference of the BWC took place in 1981, at which time it was decided to continue the practice of convening review conferences every five years. The second review conference was held in 1986, the third in 1991, the fourth in 1996, the fifth in 2001 (reconvened in 2002), and the sixth will be held in 2006. During the first review conference, state parties decided to begin a process to strengthen the convention by developing so-called confidence-building measures (CBMs), or measures that when enacted by state parties serve to build confidence in the operation of the convention (United Nations Review Conference. . . 1980). These efforts continued at the second and third review conferences, culminating in the development of a set of CBMs that enjoin state parties, among other requirements, to report on their biological defense programs, including the facilities involved in these programs. These reports are supposed to be made on an annual basis and submitted to the United Nations Department of Disarmament Affairs.

Of interest for this report is that the governments of both the USSR and the Russian Federation have listed AP facilities in their annual CBM submissions. Referring to Table 2, it can be seen that in 1987, the USSR government named four AP institutes and one AP station in its annual submission and that in 2002, the Russian government named four AP institutes in its submission. These official declarations provide evidence that the AP system was substantially involved in the Soviet biodefense program and that this involvement continued in Russia as late as 2002. (No new details have been added to the Russian CBM submissions since 2002.)

In this regard, it is useful to consider the institutions that the Soviet and Russian governments have officially declared in the CBMs as being involved in the biodefense program. In the 1987 CBM declaration, the three lead *Problem 5* institutes—

TABLE 2

USSR MOH and Russian MOH Institutes Named in 1987 and 2002 Submissions to the United Nations Department of Disarmament Affairs as Part of Confidence Building Measures Agreed on at the Second and Third Review Conference of the Biological and Toxin Weapons Convention (the spelling and the order in which presented are as in the original documents)

1987[21]	2002[22]
Belorussian Research Institute for Epidemiology and Microbiology, Minsk	Mikrob Russian Antiplague Research Institute of the Russian Federation Ministry of Health
D.I. Ivanovsky Institute of Virology, Moscow	Rostov-on-Don Antiplague Research Institute of the Russian Federation Ministry of Health
N.F. Gamaleya Institute for Epidemiology and Microbiology, Moscow	Volgograd Antiplague Research Institute of the Russian Federation Ministry of Health
Irkutsk Anti-Plague Scientific Research Institute of Siberia and the Far East, Irkutsk	Irkutsk Antiplague Research Institute of Siberia and the Far East of the Russian Federation Ministry of Health
Moscow Research Institute for Viral Preparations, Moscow	N.F. Gamaleya Institute for Epidemiology and Microbiology of the Russian Academy of Medical Sciences
Scientific Research Institute for Poliomyelitis and Viral Encephalitis, Moscow	D.I. Ivanovsky Virology Research Institute of the Russian Academy of Medical Sciences
Volgograd Anti-Plague Research Institute, Volgograd	
Mikrob All-Union Anti-Plague Scientific Research Institute, Saratov	
Georgian Anti-Plague Station, Tbilisi	
Rostov-on-Don State Anti-Plague Institute, Rostov-on-Don	

Gamaleya, Ivanovskiy, and Chumakov—were declared, as were Mikrob and the Irkutsk, Rostov, and Volgograd AP institutes. In addition, one AP station was declared: the Georgian Anti-plague station in Tbilisi (see Table 2). That the Gamaleya, Ivanovskiy, Chumakov, Irkutsk, Mikrob, Rostov, and Volgograd institutes were declared in the 1987 CBM makes sense because all of them were, to a lesser or greater extent, involved in *Problem 5*. Further, the fact that the Almaty AP Institute and the Stavropol AP Institute were excluded is not a significant lapse because they appear to have played very small roles in *Problem 5*. But why did the Soviets declare only one out of the approximately 80 AP stations existing at that time?

Though we cannot explain with any degree of certainty why the Soviet government declared only one AP station, we have found some clues that the Georgian AP station enjoyed a special status. First, in size and programmatic activity, this station was equal to the AP institutes. It had a strong scientific research program that focused on dangerous pathogens such as *F. tularensis*, *Y. pestis*, other *Yersinia* species, and viral pathogens. In fact, the station's scientific program was so robust that it was granted the right to be a site where dissertations could be defended and was authorized to grant the candidate's degree (see Appendix 3 for an explanation of Soviet academic degrees). Second, the Laboratory of Especially Dangerous Viral Infections was established at the Georgian AP station in 1979 as part of the special effort to defend against possible acts of bioterrorism during the 1980 Moscow Olympics. The station thus had a strong defense focus in regards to viral diseases. Third, the Georgian SSR at that time had a unique biological resource, namely the Institute of Experimental Pathology and Therapy that housed the Sukhimi Primate Center. Having been established in 1927, this was the world's oldest primate research center; it housed over 7,000 monkeys and employed more than 1,000 persons including 300 researchers (Fridman 2002). Thus, the AP station could quickly obtain a large number of monkeys for laboratory experiments involving dangerous pathogens. For all these reasons, the Georgian AP station may have been more heavily involved in *Problem 5* than the Almaty AP Institute and the Stavropol AP Institute, as well as any other AP station. The Georgian AP station's high level of capabilities, special resources, and deep involvement in biodefense activities may explain why it was declared by the USSR under the BWC confidence-building measures.

[21] Union of the Soviet Socialist Republics, "Information presented by the USSR in compliance with the agreements reached at the second Conference for examination of the Convention on the prohibition of development, production, and stockpiling of bacteriological (biological) and toxin weapons and their elimination, and in accordance with the resolutions and recommendations of the special Meeting of scientific and technological experts from the participating countries. (Data concerning the Ukrainian and Byelorussian Republics are also included in this information)," United Nations Department of Disarmament Affairs, October 13, 1987.

[22] Russian Federation, "Information on Facilities and Biological Activity of the Russian Federation Related to the Convention on the Prohibition of Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (in Russian)," United Nations Department of Disarmament Affairs, DDA/BWC/2002/CBM, May 23, 2002.

CONCLUSION

Western security analysts have learned a great deal about the ostensibly civilian component of the Soviet offensive BW program. We know that by the late 1980s, the program had reached its peak; by that time it probably was more than 10 times larger than the BW program possessed by the United States before 1969 and more than 100 times larger than Iraq's pre-1991 BW program. It is also clear that in addition to its remarkably large size, the Soviet BW program was scientifically sophisticated, employing advanced biotechnologies, including genetic engineering, to develop modified bacterial and viral strains for weapons purposes.

While it is always a chancy proposition to assess a program that has been deliberately obscured, it probably is safe to assume that more is unknown about the Soviet BW program than is known. In particular, little or no information is available about its intent, the overall direction of the program by the USSR MOD, the accomplishments of the military biological facilities, the roles and responsibilities of the non-MOD ministries and national academies in this program, and the roles and responsibilities of the USSR MOH, including the AP system, in the offensive and defensive BW efforts.

As to the last item, this report has clarified the contributions made by the AP system to the Soviet BW programs. Bearing in mind the limitations on the available information described in the introduction, we believe that the AP system contributed to the offensive Soviet BW program in four ways:

- It provided a "legend" for the offensive BW program, *Ferment*, allowing Soviet officials to present it as strictly a defensive program.
- The AP system almost certainly supplied strains of virulent pathogens to Biopreparat and MOD biological facilities that subsequently were developed for military purposes. The most likely candidates for weaponization were strains of *B. anthracis*, *F. tularensis*, and *Y. pestis* that had been recovered from natural disease foci in the southern, southeastern, and southwestern regions of the USSR. Further, it appears as if at least one AP institute, the Volgograd AP Institute, actively collaborated with several Biopreparat institutes under *Ferment* to develop strains of *Pseudomonas* (renamed *Burkholderia*) for weapons purposes. This collaboration went beyond the mere supplying of strains from the Volgograd AP Institute to Biopreparat and probably included efforts to weaponize wild bacterial strains (Biopreparat scientist 2003).
- Methodologies that the AP facilities had developed for handling, growing, and propagating dangerous pathogens, including those with fastidious growth requirements, probably were made available to MOD and Biopreparat scientists. Thus, rather than having to undertake difficult and dangerous research to develop their own techniques for controlling and utilizing pathogens, MOD and Biopreparat scientists could easily access the reports and expertise of the AP system and adapt them for their own purposes.
- The AP system trained MOD scientists to control and handle highly dangerous pathogens. It is reasonable to assume that at least some MOD scientists utilized this knowledge for research and development aimed at weaponizing pathogens.

The contributions of the AP system to *Problem 5* cannot be fully assessed at this time, mainly because it is hard to determine the intent of the program beyond generalities. We do not have sufficient information for a clear overview of the tasks undertaken under *Problem 5* or the criteria that the MOD used to evaluate whether the program was successful. For instance, no one in a higher position at the MOD's 15th Directorate or at the 2nd and 3rd Directorates of the USSR MOH has revealed anything about what was expected of the AP system and whether those expectations were fulfilled. It is also reasonable to believe that the 30 classified volumes reportedly housed in the Gamaleya archives contain a great deal of information about *Problem 5* tasks, but these records remain closed to outsiders. Although several former and current AP scientists outside Russia have been willing to talk about the work they did at AP facilities, they were not in sufficiently high positions to know about *Problem 5* or its tasks and hence cannot provide a clear overview of the program. Even the directors of non-Russian AP facilities, who might be expected to know about the tasks their facilities performed under *Problem 5*, do not understand how this work fit into the overall structure of the Soviet BW program or about work done at other facilities. Therefore, until the still-secret archives kept by the Russian MOH and Gamaleya are opened to scholars, no outsider will be in a position to learn about more than a fraction of the work carried out under *Problem 5*.

Drawing on what little is currently known about *Problem 5*, we believe that the following three accomplishments can be accorded the Soviet AP system:

- Earlier than most Western nations, the USSR set up specialized teams that were trained to respond to biological disasters.[23] Since we do not know about the accomplishments of SPECT teams, we cannot assess whether they represented a positive development for public health in the USSR. Had they faced a biological emergency brought about by a natural outbreak or biological attack, however, two opposing factors would have affected their effectiveness. On the one hand, Soviet public health officials were able to impose

[23]The U.S. established the Epidemiological Intelligence Service (EIS) in 1951 that utilized multidisciplinary teams to investigate disease outbreaks (Langmuir & Andrews 1952, 235–238). Since the Soviet Union is known to have copied other American initiatives, it could be that Domaradskij read about the EIS in the open literature and once in a position of power decided to try to establish something similar.

draconian measures, such as mandatory vaccination and quarantine, which would have helped them in limiting the spread of a disease outbreak. On the other hand, the extreme secrecy measures characteristic of the Soviet system, including the refusal to acknowledge certain types of infectious disease outbreaks, prevented local health officials from properly assessing an outbreak and seeking the outside assistance needed to respond effectively. Furthermore, other communities close to the disease-affected area probably would have been kept in the dark about the outbreak and would have been unable to take appropriate steps to protect themselves.

- It is certain that AP scientists made important discoveries and developed valuable new methodologies that, because of secrecy restrictions, were classified and therefore remained unknown to the international scientific community. For example, Domaradskij claims that his team discovered that *Y. pestis* cells contain plasmids several months before this discovery was announced in the West, but he was forbidden to publish his results. In addition, whereas the AP system published some information on vaccines in the open literature, studies that dealt with the development of new vaccines were classified (Biopreparat scientist 2003). There are probably many other examples of important discoveries by Soviet scientists that were classified. Unfortunately, we are not in a position to assess the extent to which such secret research benefited *Problem 5*.
- The AP system trained MOD scientists to control and handle highly dangerous pathogens, skills that they probably used in defensive research and development efforts carried out at military biological facilities.

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APPENDIX 1: BIOSKETCH OF PROFESSOR IGOR VALERIANOVICH DOMARADSKIJ

Dr. Domaradskij graduated with honors from the Saratov Medical Institute in 1947 and completed his graduate studies in 1958. He then worked at Mikrob in Saratov. After defending his doctoral dissertation in 1956, Dr. Domaradskij became Chairman of Mikrob's Department of Biochemistry and Biophysics. In 1957, he was appointed director of the Irkutsk AP Institute, where he worked until 1964. While at Irkutsk, Dr. Domaradskij established work contacts with public health agencies in Mongolia, China, and Vietnam, which helped strengthen sanitary border controls. Dr. Domaradskij led several successful research programs focused on the microbiology of pathogens of several high-risk infectious diseases as well as studies related to the biochemistry and pathogenesis of plague at a newly built biochemistry laboratory. The findings from these studies usually were published in the Irkutsk AP Institute's two series of publications, *Trudy* (*Works*) and *Izvestia* (*News*).

In 1964, Dr. Domaradskij was appointed director of the Rostov AP Institute, which he headed until 1973. Under his guidance new scientific findings were obtained on the genetics and metabolism of the plague and cholera pathogens. Dr. Domaradskij made a significant contribution to resolving the problem of protecting the Soviet population and armed forces from plague by using modern genetic methods to develop a new variety of the *Y. pestis* EV vaccine strain resistant to the most widely used antibiotics. This made it possible to use these antibiotics with simultaneous vaccination for emergency prevention and treatment of plague. Dr. Domaradskij also developed new guidelines for the USSR MOH for sanitary border controls. One of the elements of this new approach was the creation of fully equipped specialized mobile antiepidemiological brigades. These and similar brigades organized at other AP institutes played an important role in mitigating consequences of the cholera epidemics that struck the USSR in 1965, 1970, and later years. Under Dr. Domaradskij's leadership, the Rostov AP Institute became the lead Soviet research institute dedicated to the studies of cholera. Dr. Domaradskij directed and participated in efforts to contain cholera epidemics in Karakalpakia (Uzbekistan) in 1964 and in the southern part of Russia in 1970 and 1971. In addition, Dr. Domaradskij led expeditions that mapped and studied natural plague foci in the mountainous parts of Altai region and in Tuva.

It is noteworthy that for 14 years, Dr. Domaradskij directed the plasmid scientific program of the Soviet Union, which played an important role in describing many aspects of the molecular genetics of microbes. In this regard, Dr. Domaradskij was one of the authors of the patented scientific discovery proving the connection between the pathogenicity of the plague microbe and the presence of plasmids in the *Y. pestis* cell. Dr. Domaradskij's other scientific achievement was proving in 1976 that plasmids can be transferred from *E. coli* to gram-positive bacteria.

From 1973 until 1976, Dr. Domaradskij worked at Glavmikrobioprom (Main Directorate for Microbiological Industry) in Moscow. In this capacity he founded the first Soviet laboratory specializing in carrying out studies of extrachromosomal heredity. Dr. Domaradskij also served briefly as chairman of the Soviet Union's secret Interagency Science and Technology Council on Molecular Biology and Genetics, which directed the secret work of Biopreparat, the ostensibly civilian lead agency of the Soviet offensive BW program.

In recent years, Dr. Domaradskij has been affiliated with the G.N. Gabrichevskiy Scientific-Research Institute of

Epidemiology and Microbiology, where as a chief scientist he has been engaged in a number of scientific research projects, including collaborative research with the Ultrasan Corporation on the development of new approaches towards the treatment of disbacteriosis (a disorder of normal bacterial flora of the intestinal tract).

Dr. Domaradskij has been honored by highly prestigious professional and academic awards, including the Order of Lenin, Order of Peoples' Friendship, Excellence in Public Health Badge, Excellence in Microbiology Industry Badge, and many others. He is an academician of the Russian Academy of Medical Sciences and a founder and active member of the Russian Academy of Natural Sciences. Over the years, he has mentored 58 candidates of sciences and 14 doctors of sciences. Dr. Domaradskij patented 46 inventions and is the author of approximately 400 scientific works, including 10 monographs such as *Ocherki patogeneza chumy* (*Notes on Plague Pathogenesis*) in 1964, *Biokhimiya i genetika vozbuditelya chumy* (*Biochemistry and Genetics of Plague Pathogen*) in 1974, *Chuma* (*Plague*) in 1998, and *Vvedeniye v ekologiyu bakteriy* (*Introduction to Ecology of Bacteria*) in 1998.

Dr. Domaradskij's only book in English was published in October 2003: Igor V. Dr. Domaradskij and Wendy Orent, *Biowarrior: Inside the Soviet/Russian Biological War Machine*, Prometheus Books.

APPENDIX 2: EXPLAINING "NATURAL DISEASE FOCUS" AND "NATURAL DISEASE FOCI"

Throughout this report terms such as "natural disease focus," "natural disease foci," and "natural plague foci" are used. The notion of natural disease focus or foci stems from the work begun in the late 1930s in the USSR by Academician E.N. Pavlovskiy (1964), who developed the theory of natural focality of human disease agents. In other words, some pathogens, such as *Yersinia pestis* and *Francisella tularensis* (which cause respectively plague and tularemia), tend to exist naturally in certain definable regions (natural foci) where they live a saprophytic existence in the soil and/or as parasites that colonize preferred hosts (carriers) and vectors. According to Pavlovskiy, natural foci diseases affecting humans include plague, tularemia, tick-borne and Japanese encephalitis, rabies, various leptospiroses, dermal leishmaniasis, tick-borne relapsing fever, and some helminthiases such as opisthorchiasis and trichinosis.

Scientific investigations based on Pavlovskiy's theory has since then evolved through three stages. At the first stage, the emphasis was on exploring the interactions between the pathogen, its vector, and its preferred host. For example, a natural plague focus would be a region where *Y. pestis* on a dependable basis can be recovered from certain warm-blooded animals, and their ectoparasites, that live in that region and, possibly, the region's soil, plants, and/or soil protozoa (Gage & Kosoy 2005).

During the second stage, field investigations made clear that the vector is not necessarily a structural component of every natural disease focus, especially in regards to non-transmissible diseases. For example, a natural anthrax focus would be a region where *Bacillus anthracis* on a dependable basis can be recovered from the soil and, at times, warm blooded animals inhabiting it.

And during the third stage, field investigators gained the understanding that the presence of a warm-blooded host in the natural disease focus might be unnecessary for pathogen survival—a natural focus can consist of only soil and aquatic ecosystems. For example, *B. anthracis* spores can survive in a natural anthrax focus's soil for decades or longer without ever coming into contact with warm-blooded animals. In the final analysis, the one vital component of all natural disease foci thus is the pathogen population.

Research by Russian scientists has demonstrated that natural plague foci have been in existence for many millions of years over extensive areas of the Earth's surface, including millions of square kilometers that are nearly untouched by human activity (Litvin & Korenberg 1999). Natural disease foci are dynamic entities, in continuous process of shrinking or expanding depending mainly on natural forces, such as weather patterns, but also by human activities. Thus, natural malaria foci tend to expand in years of high heat and rain fall, and decrease in years of drought and coolness. As for human activities being an important determinant on natural disease foci, a good example of how human intervention influenced a natural focus involves tularemia, which is a zoonotic bacterial disease caused by *F. tularensis*.

The warm-blooded animal reservoirs of this pathogen are mammals of the genera *Lagomorpha* and *Rodentia*, while its vectors are ixodic ticks and other blood-sucking insects. Tularemia is predominantly a disease of the northern hemisphere, and large regions of Russia are natural tularemia foci. Despite the prevalence of *F. tularensis* in many Russian *oblasts*, the number of human cases annually usually is low, in the ten thousands. However, during the early days of World War II, in 1942, the morbidity rate suddenly shot up into the hundreds of thousands, affecting both German and Russian soldiers (Pollitzer 1967). The most likely reason for this increase was that the natural tularemia focus in the region near Stalingrad (now Volgograd) expanded. This occurred because the war prevented farmers from harvesting their grain, leaving plants to rot in the fields. With this over-abundance of food, the population of field mice, which are carriers of *Francisella tularensis*, exploded, leading to an enormously increased number of interactions between the mice and humans. It is said that mice were everywhere; in the trenches and cellars where soldiers took refuge, crawling into unattended beds and sleeping bags, defecating and urinating in huts and tents, and so forth. The ingestion and inhalation of large numbers of *Francisella tularensis* bacteria by soldiers therefore was unavoidable, leading to a greatly increased tularemia morbidity rate.

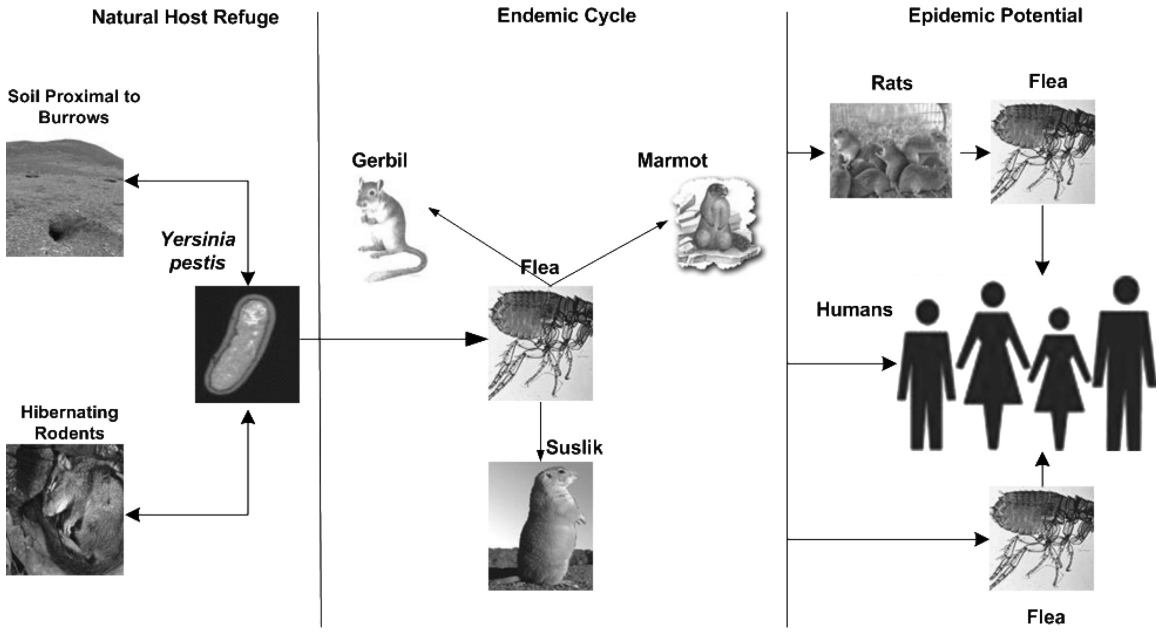

FIG. 1. Endemic Cycle of *Yersinia pestis* and Outbreak Potential.

Under certain circumstance, natural disease foci might also become dangerous sources of pathogens that cause disease outbreaks affecting nearby human populations. In this case, humans become accidental hosts to the pathogen (see Figure 1). An especially threatening situation has developed over the last few decades in Central Asia as an ever growing number of people have moved into regions hosting a variety of natural disease foci, mainly because the extraction industry in this region has been expanding rapidly. Initially, no one was in a position to determine whether this population increase in formerly uninhabited or sparsely inhabited regions would lead to more people being exposed to dangerous pathogens or if the effects would be negligible. The early recognition of the problem in the 1960s and 1970s by Soviet AP scientists led the government to support the undertaking of many large-scale projects for the purpose of eliminating or shrinking natural plague foci (Diatlov 2001). Some of these projects focused on exterminating rodents that were carriers of plague bacteria; others on killing the ectoparasites populating rodents in order to prevent the transmission of pathogens among rodents. These attempts appear to have had no, or at the most a limited, effect on plague demographics of the region.

After 1992, when the dissolution of the USSR also led to a splintering of its AP system, a new, unfavorable situation has arisen; due to limited resources AP scientists are no longer able to conduct adequate field studies of natural disease foci. As a result, no one has accurate information as to the activity levels of many of the region's natural disease foci. This situation and its implications will, however, be considered in detail in the second report.

APPENDIX 3

Comparison of U.S., Soviet, and Russian Academic Degrees

U.S.	Soviet Union	Russia
BA/BS (4 years)	*Spetsialist* (5 years)	*Bakalavr* (Baccalaureate) 4 years
MA/MS (2 years, often involves thesis)		*Magistr* (Master's) 2 years
		Many universities and institutes continue to offer s*petsialist* degree rather than separate BA/BS or MA/MS programs

APPENDIX 3

Comparison of U.S., Soviet, and Russian Academic Degrees *(Continued)*

U.S.	Soviet Union	Russia
Ph.D./Sc.D (3 years or more + dissertation)	*Kandidat nauk*[24] • usually translated as "Candidate of Science"	*Kandidat nauk*
	Doktor nauk[25] • usually translated as "Doctor of Science" Russian *kandidat* and *doktor nauk* degrees are both often treated as equivalents to the US Ph.D. without any particular distinction between them. However, in some cases *kandidat degree* (particularly in social science programs from non-leading Russian universities) is treated in the United States as a master's degree. In hard science, it is much more common to treat Russian *kandidat nauk* degree as equivalent to a Ph.D.	*Doktor nauk*
MD	*Vrach*[26]	*Vrach*

[24]The *Kandidat nauk* degree was introduced in Russia (USSR) in 1934. It is awarded to those who pass the relevant degree examinations and defended a kandidat's dissertation. Usually it takes two to three years to complete the program and defend a dissertation.

[25]The *Doktor nauk* degree was introduced in Russia in 1819, abolished in 1917, and revived in the Soviet Union in 1934. It is awarded to those who have accomplished independent research that elucidates theoretical principles and solves scientific problems representing an important contribution to scientific knowledge and practice. No fixed time period for completion. Public defense of doctoral dissertation is required.

[26]Medical school is a six-year program of higher education. Graduates of this program receive the title of *vrach* (medical doctor). However, in order to practice, they need to complete further specialized training, for which four options are available:

Internatura (internship). This is a one-year program that leads to certification in one of the basic specialities, such as bacteriology, infectious diseases, psychiatry, epidemiology, etc. In reference to infectious diseases, upon completion of the program the graduate would receive the title of *vrach bakteriolog* (doctor bacteriologist).

Ordinatura (residency). This is a two-year program that leads to certification in a basic specialty or in a subspecialty.

Aspirantura (candidate of science). This is a two- to three- year program that awards a *Kandidat nauk* (candidate of science) degree in a medical specialty or subspecialty.

Doktorantura (doctor of science). This is a program that takes a further three years beyond *aspirantura* and leads to a *Doktor nauk* degree. Someone completing *doktorantura* in the medical field would be both a doctor (*vrach*) and have a doctorate degree (*Doktor nauk*).

The first two (*internatura* and *ordinatura*) denote practicing doctors, while *aspirantura* and *doktorantura* are indicative of research and teaching careers. However, in all four cases, a person could be referred to as "doctor bacteriologist," "doctor epidemiologist," etc.