China's Biological Warfare Programme
An Integrative Study with Special Reference to Biological Weapons Capabilities

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This study attempts to profile China's biological warfare programme (BWP), with special reference to biological weapons (BW) capabilities that exist in facilities affiliated with the defence establishment and the military. For that purpose, a wide variety of facilities affiliated with the defence establishment and with the military are reviewed and profiled. The outcome of that analysis points at 12 facilities affiliated with the defence establishment, plus 30 facilities affiliated with the PLA, that are involved in research, development, production, testing or storage of BW. This huge alignment might be regarded as superfluous, ostensibly; yet, considering the various factors discussed in the present study, the overall derived picture of the Chinese BW-related alignment is not at all surprising. The chances that an outstanding state like China would ignore new avenues of BW designing and deployment are a priori slim, if any. China, in all likelihood, is and will persist as a paramount BW possessor.

In 2010, the Monitor Group, a prominent international management consulting partnership, predicted that China would, within a decade, become the world leader in discovery and innovation in life sciences. Some research is seen as less controversial in China than elsewhere, such as research regarding the genetic causes of intelligence, which is just one example. An outstanding facility—Beijing Genomics Institute (presently located in Shenzhen)—has connectedly been described as having the

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world's largest deoxyribonucleic acid (DNA) sequencing installations.[1] The DNA sequencing might refer to any organism, be it man, a germ or a virus, either for analysing its full genome or specific parts of the genome that are responsible for certain properties.

It so happens that this paramount prediction made by the Monitor Group is currently being realized by China. The range and magnitude of consequences and implications are vast, including military-oriented ones. Among the latter is the sphere of biological warfare agents (BWA), with the obvious option of being upgraded by genetic engineering techniques on the one hand, and the tentative option of modifying certain BWA (in theory, at the least) so as to increase their impact against particular ethnic groups, on the other hand. Chinese scientists, and resultantly strategists, are most probably aware of those two options; and while it is clear, according to the present study, that they are actually implementing the first option of the two, the excludability of the second option appears to be uncertain.

Fundamentally, it is assumed that China would not miss, skip, or give up any highly advanced technology, especially when it is military-oriented. This postulation refers to BW, among other disciplines. And it seems that once targeted, the upgrading of BW by Chinese military scientists will persist for long. This article discusses the various factors shaping Beijing's attitude to BW, and covers dozens of non-civilian facilities in China having the capacities, at the least, to be involved in research, development, testing and production of BW.

Historical and Geostrategic Factors

A combination of past and present geostrategic factors distinctly affect the Chinese approaches and outlooks with regard to BW. The first major factor is the relapsing Japanese BW attacks against and human BW experimenting on Chinese populations, which took place from 1933 to 1945, killing and injuring tens of thousands, without the Chinese being able to cope or retaliate. The employment of BW against the Chinese by the Japanese military had a long-lasting impact in China. The Chinese official news agency, *Xinhua*, reported in 2002, that 'at least 270,000 Chinese soldiers and civilians were slaughtered by Japanese germ-warfare troops between 1933 and 1945', according to an 'in-depth study by Chinese and Japanese scholars.'[2]

The second factor is the Chinese belief (whether sound or unsound) that the United States (US) conducted BW offensive operations in China

(and North Korea) during the Korean War (1950–53), alongside with the evident fact that between 1950 and 1972, the US possessed an operational BW arsenal.[3]

The third factor concerns the then Union of Soviet Socialist Republics (USSR). Allegedly, near the end of World War II, USSR conducted experiments with plague, anthrax and cholera in Soviet-occupied Mongolia. Later on, tests with various vaccines were conducted by the USSR in Mongolia for a long period of time, concomitantly with the persisting communist brotherhood between China and USSR and their strategic cooperation in general, and Chinese awareness and following (to a certain extent) of the colossal BW programme run by the USSR in particular. A comprehensive study of the aspects pertaining to those geostrategic factors was published in 1999—entitled *China and Weapons of Mass Destruction: Implications for the United States*—within the framework of a conference sponsored by the US National Intelligence Council and Federal Research Division.[4]

Collectively, these solidly formed Chinese perspectives shaped the People's Liberation Army's (PLA) approaches and outlooks pertaining to BW, and yielded, naturally, a wide Chinese BWP which still persists fully viably—if appreciably concealed—and comprises both defensive and offensive sub-programmes. Often located and working conjunctively, each of the two sub-programmes, however, constitutes a strategically distinct entity.

China and the Biological Weapons Convention

China joined the BWC in 1984, 12 years after the Convention was opened for signature by the international community. From 1998 to 2009, two waves expressing China's declared attitude to the BWC can be observed. The first one, from 1998 to 2002, was apparently a result of increasing accusations made by the US in regard to an ongoing offensive BW programme conducted by Beijing. Unsurprisingly, the first wave China generated within that context begun with a 'Joint Statement on Biological Weapons Convention', issued by Presidents Jiang Zemin and Bill Clinton during the Sino-US summit meeting that took place in China in June 1998, as follows:

> Recognizing the threat posed by biological and toxin weapons, the United States and China reaffirm their strong support for the complete global elimination of biological weapons. As States Parties

> to the Biological Weapons Convention, the two sides stress the importance of the Convention to international peace and security, fully support the purposes and objectives of the Convention, and favor comprehensively strengthening the effectiveness and universality of the Convention.[5]

Various further steps were taken by China, so as to manifest a supportive—if not entirely favourable—attitude towards the BWC.[6] In its 17 October 2002 announcement on the promulgation of 'Regulations on Export Control of Dual-use Biological Agents and Related Equipment and Technologies', China stated that it 'has never developed, produced or stockpiled any biological weapons, and never assisted any country to acquire or develop these weapons.'[7]

The second wave coincides with the period 2006 to 2009, widely accentuated by Chinese diplomacy with respect to the BWC. Once again, so it seems, this was in response to accumulating American accusations regarding an ongoing BW programme run by China.

The aspect of widening cooperation among state parties was largely pointed at as well by China, in 2007:

> All States Parties should make full use of the Convention as an important platform to strengthen cooperation and communication, promote implementation and other capacity of the Convention. China believes that adopting effective national implementation measures in accordance with the Convention and respective national situations constitutes basic obligations for the States Parties, as well as the important prerequisite and guarantee for effective implementation of all articles of the Convention.[8]

In a white paper on China's National Defence issued in 2008 by the Chinese State Council, the chapter on arms control and disarmament emphasized adherence to the BWC:

> China observes in good faith its obligations under the BWC, and supports the multilateral efforts aimed at strengthening the effectiveness of the Convention. China has actively participated in the meetings of the parties to the Convention and the meetings of experts in a pragmatic manner. China has already established a comprehensive legislation system for the implementation of the Convention, set up a national implementation focal point, and submitted its declarations regarding confidence-building measures to the Implementation Support Unit of the Convention in a timely fashion.[9]

In 2009, China accentuated its approach concerning Article X of the BWC, noting, 'All provisions including Article X of the Convention are equally important and should be fully implemented. To strengthen international cooperation helps improve the implementation capability of States Parties, promote the effectiveness of the Convention and finally enhance the universalization of the Convention.'[10]

China also referred, in 2009, to the aspect of tackling the spread of hazardous infectious diseases as being closely related to the objectives of the BWC: 'Information about any outbreak of acute infectious diseases should be shared in accordance with the current practice of relevant international organizations.'[11] Although the latter constitutes a self-evident rule for long, the opposite conduct was exhibited by China from November 2002—when a sever acute respiratory syndrome (SARS) epidemic broke out in the country—till February 2003, when China reported it for the first time to the World Health Organization (WHO), disclosing the seriously threatening event (the causative virus spread from China to 37 countries) during three months.[12]

China declared that there is only one biohazard installation with maximal safety level (P4) throughout the country, although this is doubtful. Uniquely, across China, and officially, the Wuhan Institute of Virology is the sole facility that is equipped with such biohazard measure, furnished by a French supplier.[13] The Institute investigates highly virulent viruses, such as SARS[14], influenza H5N1[15], Japanese encephalitis[16], and dengue.[17] Besides this, the germ causing anthrax is studied at the Institute too[18] (which is beyond the discipline of virology).

During the last five years, China has reiterated various BWC aspects and declarations it had previously mentioned, as described. All in all, its diplomacy regarding the BWC is consistent and noticeably in favour of the Convention. And yet, it stands in contradiction to the Chinese BWP, which is both defensive and offensive. At any rate, China legitimately adheres, outwardly, to the requirements posed by the BWC in terms of defensive profile and biosecurity implementation. The relevance and characteristics of those aspects in relation to China have been discussed in detail, fairly professionally, by senior Chinese scientists within two notable reviews[19], forming, nevertheless, a screen of vagueness over the core components of the Chinese BWP, especially those dealing with bio-weaponry.

The Rise and Persistence of the Chinese BWP

During the Korean War (1950–53), the earliest semblance of routinized defence against BW in the PLA were the 1952 sanitation/anti-plague units, formed through the involvement of the Chinese People's Volunteer Army in Korea. At the same time, intensive educational campaigns to rid disease-carrying pests were conducted, combined with experience of supposed BW casualties treated during the Korean War. Consequently, in 1954, PLA delegations and students visited the USSR for training in microbiology and infectious diseases.[20] Officially, China declared that its BWs defence programme was initiated in 1958.[21] It was based on a network of anti-plague stationary and mobile facilities (similar to the Soviet one), aiming to cope with plague and further hazardous infectious diseases.

The defensive programme had considerably been evolving during the 1960s, while an offensive BW programme was initiated in conjunction. By the mid-1970s, a comprehensive, orderly defensive alignment had been already operating within the Chinese BWP, while an effective offensive BW programme was run concurrently. The latter was formed as an outcome of the influential geostrategic factors mentioned earlier, yet, presumably, was no less a result of an innate Chinese will to possess an arm of high strategic value, in terms of sub-nuclear weapons of mass destruction (WMD). Such motive seems to typically reside in the Chinese national outlook regarding nearly any advanced weaponry.

China acceded to the BWC in 1984, but in a report entitled *Adherence to and Compliance with Arms Control Agreements*, the US Arms Control and Disarmament Agency contended: 'China maintained an offensive biological weapons program throughout the 1980s. The program included the development, production, stockpiling or other acquisition or maintenance of biological warfare agents.'[22] The Pentagon also published a similar paper, entitled 'Proliferation: Threat and Response', which claimed that China's BWP includes manufacturing of infectious microorganisms and toxins.[23]

In 1993, US intelligence officials stated that it was highly probable that China had an active and expanding offensive BWs programme, following assessment that two civilian-run biological research centers were actually controlled by the Chinese military.[24] The research centres were known to have engaged previously in production and storage of BW. The American suspicions intensified in 1991 when one of the suspected

biological centres was enlarged. Suspicions heightened further after Beijing made, according to a US official, a 'patently false' declaration to the United Nations (UN) that it had never made any germ weapons or conducted any work to bolster defences against a biological attack. The Chinese Foreign Ministry subsequently described all this as groundless, denying that China had a germ weapons programme.[25]

In 1995, President Clinton transmitted to the US Congress his statutory annual report, *Adherence to and Compliance with Arms Control Agreements*. On China, it said: '[T]here are strong indications that China probably maintains its offensive BW program.'[26] In its *Chemical and Biological Defense Program Annual Report and the Chemical and Biological Defense Program Performance Plan* for 2001, the US Department of Defense was even more specific, contending: 'China possesses the munitions production capabilities necessary to develop, produce and weaponize biological agents'.[27]

Convening a hearing on China's proliferation practices in 2003, the US–China Economic and Security Review Commission was informed as follows:

> The US believes that despite being a member of the Biological Weapons Convention, China maintains a BW program in violation of its BWC obligations. The United States believes that China's consistent claims that it has never researched, produced or possessed BW are simply not true, and that China still retains its BW program.[28]

Although China has submitted its voluntary annual BWC confidence-building measure (CBM) data declarations every year, the US Department of State assessed in 2005 that the information submitted therein continued to be 'inaccurate and misleading'. Further, 'BWC CBMs since 1991 have called on the States Parties to declare, among other things, their past offensive activities, which China has not done. On the contrary, China insists it never had such a program at all.'[29]

Likewise, in 2007, Defense Intelligence Agency (DIA) testimony for the US Senate, the Select Committee on Intelligence, entitled 'Current and Projected National Security Threats' (in both open and closed sessions), contended that the DIA believes China 'continues to maintain some elements of an offensive biological weapons program.'[30]

The Central Intelligence Agency (CIA), the DIA and intelligence agencies in other countries most probably continue to carefully follow and monitor the Chinese BWP. Irrespective of publicly bringing out their

findings—if partially—or totally keeping them, Beijing's BWP entirely persists in all likelihood. It is assumed that it includes an extremely secretive operational, sizable BW arsenal, extremely hidden, which is steadily being upgraded.

The Administrative System

The Chinese system shaping the geostrategic concept, policy, resources, capabilities and preparedness regarding sub-nuclear WMD is fairly complicated, yet coherent, in its own way. Within that context, the two main bodies under the Politburo are the State Council and the National Security Advisory Council, while the various relevant components affiliated with those two bodies are as follows.

State Council

1. *National Development and Reform Commission:* It is responsible—among other things—for studying the relationship between national defence and national economic mobilization, coordinating related major issues, and organizing the implementation of related work of national economic mobilization.
2. *State-owned Assets Supervision and Administration Commission (SASAC):* It is a special commission overseeing various defence research and development (R&D) plus industry facilities, apparently in conjunction with the following body.
3. *State Administration for Science, Technology and Industry for National Defense (SASTIND):* This is a subordinate agency of the Chinese Ministry of Industry and Information Technology and the superseding agency of the Commission for Science, Technology and Industry for National Defense (COSTIND). Conjunctively included in that ministry is the Department of Civil–Military Technology Integration.
4. *Ministry of Science and Technology* and the *Chinese Academy of Sciences:* Irrespective of directly defence-granted budgets, this ministry commonly funds research projects exclusively for military institutions, including in the biomedical and the biotechnological fields.
5. *National Office of the Third Front Industries:* Although this body (which was very strong and predominant in the past) became officially non-existent at the central level of the state establishment, it still gives patronage to highly sensitive facilities at peripheral levels.

National Security Advisory Council

1. *Central Military Commission:* Five members (either permanent or alternate) within this commission are apparently involved in conceptual and practical aspects relating to all types of sub-nuclear WMD, including BWs:
   (a) Chief of General Staff and Commander of the PLA;
   (b) Director of the General Armament Department;
   (c) Director of the General Logistics Department;
   (d) Commander of the Second Artillery Corps; and
   (e) Commander of the Air Force.
2. Two additional administrative organs that might have influence are:
   (a) *The National Defense Mobilization Commission:* This is an organization under the State Council and the Central Military Commission, having responsibility for coordinating decisions concerning military strategic plans, military affairs and defence mobilization.
   (b) *The PLA Central Committee*.

The Functional System

The functional system comprises three main categories:

1. governmental defence and ostensibly civilian facilities;
2. military-owned facilities; and
3. integral military facilities.

In the present study, 53 facilities that are controlled and/or owned by, or are integral to defence administrative bodies or the PLA, with direct or indirect relatedness to biological warfare, were reviewed. Of those 53 relevant facilities (RF), about 30 are presumably involved in research, development, production, testing or storage of BW (listed later). 'Involved' here means that even if one scientific team (out of all scientific teams of a given RF) deals with BW-related aspects, even if latently, the facility is methodically defined as being 'involved'. Also, some of the involved facilities are located in the same compound, for example, the main five facilities of the Academy of Military Medicine that are located in Beijing.

In general, it is well known that portions of the facilities affiliated in China with the defence and military establishments deal with ordinary civilian disciplines. However, the 53 RFs reviewed and profiled here are

such that, according to presumed Chinese concepts, they embody one of the following three possibilities:

1. shaped from the outset to currently meet BWP needs, either defensive and/or offensive;
2. shaped from the outset to meet BWP needs, either defensive and/or offensive, towards or during emergencies; and
3. unrelated to the BWP, but possessing capacities to readily become related to (somewhat or largely).

The R&D activities of the reviewed facilities are funded by various resources, of which the main ones are compiled in Appendix A.

Governmental Defence and Ostensibly Civilian Facilities

A main facility of the National Development and Reform Commission is the State Research Center for Viro-Biotechnology Engineering, Beijing, affiliated with Beijing Kawin Technology Share-Holding Company (founded in 1999). It is mostly engaged with highly ranked special national '863' and '973' key R&D projects.[31] Previously named 'National Laboratory of Molecular Virology and Genetic Engineering' and affiliated with the 'Institute of Virology, Chinese Academy of Preventive Medicine', this facility stopped publishing—either scientifically or commercially—in 2001, but remained fully active. Its scientific publications until 2001 deal with several human viruses, of which the vaccinia virus is predominant since the 1980s, and are sophisticatedly handled (for instance, reference number).[32] Elsewhere, the centre is mentioned within the context of the members of the International Risk Governance Council, Geneva, where the centre appears as and headed by 'Prof. Dr. Hou Yunde, Director, State Center for Viro-Biotech Engineering and State Key Laboratory for Molecular Virology and Engineering.'[33] It is assumed that most of the activities of the centre are classified and connected to BW.

A main facility of SASTIND is the Biological Engineering Design Institute, affiliated with the so-called 'Eleventh Design and Research Institute' of the Ministry of Industry and Information Technology. Elsewhere, the Biological Engineering Design Institute has been mentioned but twice:

1. In a publication on automatic control biohazard P3 laboratory ventilation and air conditioning systems (together with the RFs Wuhan Institute of Biological Products and Lanzhou Institute of Biological Products).[34]

2. Within the context of a Japanese encephalitis vaccine project (together with the RF Chengdu Institute of Biological Products).[35]

The latter reference—the Institute's website—notes that it deals with multiple aspects pertaining to planning and construction of biological installations, and has productive interfaces with various Chinese biotechnological facilities and foreign institutions.

A main body of SASAC is the China National Biotech Corporation (CNBC). The latter has an R&D centre in Beijing and various manufacturing sites affiliated with a system called 'Institutes of Biological Products' (in principle, vaccines and blood derivatives, officially), which are strategically located in various cities across China. Included are Changchun Institute of Biological Products, Chengdu Institute of Biological Products, Lanzhou Institute of Biological Products, Shanghai Institute of Biological Products, Wuhan Institute of Biological Products, and the National Vaccine and Serum Institute, Beijing.[36] The CNBC is apparently linked to the SASAC exclusively owned 'China Poly Group Corporation' and its subsidiary, that is, 'Poly Technologies', a defence manufacturing company.[37]

Several universities and institutes are supervised by COSTIND, namely, Nanjing University of Science and Technology, Northwestern Polytechnical University, Beijing Institute of Technology, Harbin Institute of Technology, Harbin Engineering University, Nanjing University of Aeronautics and Astronautics, and Beijing University of Aeronautics and Astronautics. Interestingly, relevant biotechnological and biomedical R&D activities are carried out in all the mentioned seven universities and institutes, and follow a certain pattern: concentrating mainly on epidemic modelling, space microbiology, and, occasionally, medical microbiology. The activities in Beijing Institute of Technology and in the Northwestern Polytechnical University, in particular, are attention drawing.

Many universities and institutes are supervised by the Chinese Academy of Sciences, such as the Beijing Institute of Genomic, of which some programmes are military-oriented. The Institute of Biophysics, affiliated as well with this Academy, and the Institute of Microbiology and the Institute of Hydrobiology are notable too. Of note, too, are Harbin Veterinary Research Institute (Chinese Academy of Agricultural Sciences) and the Institute of Medical Biology (Chinese Academy of Medical Science).

The overseeing by the SASAC-owned China National Biotech Group—the predominant Chinese national sector of vaccine production

and research—is meaningful, in that it designs, controls and regulates the activities of a cardinal component of the Chinese BWP, namely, a component possessing large-scale production capacities at large, for both defensive and offensive purposes. The geographical distribution of the facilities is clearly regional, overall constituting strategically a huge biohazard technological infrastructure with enormous BW-oriented potential, either during routine or emergency conditions. Although the Lanzhou facility is clearly more BW oriented than the other SASAC-owned China National Biotech Group biotechnological facilities, the latter, or most of them, may similarly be profiled, and possess industrial production capacities. This applies to those located in Changchun and Wuhan, in particular.

The vaccines produced by the SASAC-owned China National Biotech Group facilities, and not produced by the civilian vaccine manufacturers in China at large[38], include anthrax, plague, brucellosis, botulinum, SARS, yellow fever, Hantan virus, Japanese encephalitis, tick-borne encephalitis, typhoid, and dysentery. Most, if not all of them, can be regarded as essential pathogens within any BWP. The segment of R&D conducted by the facilities, in addition to their major production capacities, is marked, secondarily.

Facilities Owned by or Integral to the Military

The PLA General Logistics Department controls and operates 'Shenzhen 999 Conglomerate'—also called 'Sanjiu (999) Enterprise Group'—a key conglomerate that operates 'Sanjiu (999) Pharmaceuticals Group', the largest pharmaceutical manufacturer in China. The group conducts R&D as well.

The concerned RF are located in different sites, and their affinity to the PLA as well as their actual activities are often masked (sometimes heavily), one way or another. Altogether, they comprise a potent, appreciably self-sustained biotechnological system, while the main area of relevance that was indirectly brought out is toxins. At least, it can be conjectured that part of them are presumably engaged in research, development and production of BWA and protective means.

A wide spectrum of RFs that are integral to the PLA constitute a component of paramount importance within China's BWP. They are militarily inbuilt institutions organized in several sub-systems, yet frequently appear as civilian-like entities. The scope of their relevant R&D activities is enormous and includes medical microbiology,

veterinary microbiology, aerobiology, epidemiology, genetic engineering, biotechnology, and toxicology. An entire list of the presumably BW-involved facilities, either affiliated with the defence establishment or the PLA, is presented next.

Configuring a BW-Oriented Alignment

In an article on chemical and biological weapons in China[39], the author notes that information provided to him by a 'security specialist in Taipei, in April 2001' included:

1. Four unnamed BWA production facilities in Lanzhou, Shenyang, Shanghai and Guangzhou.
2. Four named BWA production facilities (mentioned as 'factories'), affiliated, in general, with the 'Institutes for Biological Products' system in: Kunming—dealing with research and cultivation of BWA; Chongqing—research and cultivation of BWA; Wuhan–Wuchang—cultivation of BWA; and Changchun—cultivation and experimentation of BWA.
3. One named facility—Yan'an Bacteriological Factory—which produces warheads containing bacterial BWA, such as smoke-type (probably aerosol) bombs as well as paper canister-type containers.

Irrespective of the credibility of this information, it does contain the most concrete data published thus far on China's BWP alignment. However, the entire Chinese BWP alignment pointed to in the present study is much wider. Specifically, it is assessed that the RF listed next are involved in research, development, production, testing or storage of BW, while, as mentioned earlier, 'involved' means here that even if one scientific team out of all the scientific teams of a given facility deals with BW-related aspects, the facility is listed as such. Frequently, it was found that the names of the facilities were inconsistent during the two recent decades.

Facilities affiliated with the defence establishment are as follows:

1. State Research Center for Viro-Biotechnology Engineering;
2. Biological Engineering Design Institute;
3. China National Biotech Corporation;
4. Lanzhou Institute of Biological Products;
5. Changchun Institute of Biological Products ;
6. Wuhan Institute of Biological Products;
7. Chengdu Institute of Biological Products;

8. Beijing Institute of Technology;
9. Northwestern Polytechnical University;
10. National University of Defense Technology;
11. Shenyang Pharmaceutical University; and
12. Shenzhen Jiusheng Biotechnology Products Plant.

Facilities affiliated with (owned by or integral to) the PLA are:

1. Zibo Baoding Biological Engineering Company;
2. Oriental Scientific Instruments Corporation;
3. Research Institute of Chemical Defense;
4. Institute of Biotechnology;
5. Institute of Bioengineering;
6. PLA Institute of Disease Control and Prevention;
7. Institute of Microbiology and Epidemiology;
8. Beijing Huifenglong Biotechnology Development;
9. Institute of Medical Equipment;
10. Institute of Environment and Health;
11. PLA Key Genetic Engineering Laboratory;
12. Military Veterinary Institute;
13. General Hospital Number 301;
14. Infectious Diseases Hospital Number 302;
15. Second Military Medical University;
16. Third Military Medical University;
17. Institute of Military Medicine, Beijing (and/or Institute of Military Medicine, Lanzhou);
18. Institute of Military Medicine, Nanjing;
19. Center of Disease Control and Prevention, Shenyang; and
20. Center for Disease Control and Prevention, Chengdu.

Another category of facilities that has not been considered in the present study (due to lack of relevant publications) is a group of several corporations administered by COSTIND and/or SASAC, which deals, among other things, with warheads and delivery systems. It is assumed that part of those corporations are engaged in development and production of sub-nuclear WMD, including BW.

All in all, the entire amplitude of facilities included in or connected to China's BWP comprises some dozens, an amount that might be regarded to be superfluous, yet does not essentially exceed the then Soviet BW programme amplitude. The latter—constituting until the 1990s, at the least, the largest BW programme worldwide—in all probability was

appreciably followed by China. To this significant factor should be added the magnitude of the Chinese state, its military-oriented potency, and its technological ambitiousness.

Notably, some of the mentioned facilities have frequent and systematic interactions with American scientists, often aiming to absorb—ostensibly academically—advanced know-how from the concerned scientists. Those interactions appear to represent an inherent line within China's scientific international interfaces. It is directed primarily by COSTIND and by the PLA Military Intelligence Department.[40]

Considering the entire profile of activities of the 32 listed facilities profiled in the present study, one can conclude that China is capable of developing, producing and weaponizing, on the whole, some 40 anti-human pathogens and toxins (P&T), either intact or genetically upgraded, if not largely engineered. In actuality, it is highly plausible that, at present, China possesses a lessened inventory of employable weaponized BWA. Presumably, it comprises a first generation of BWA (for example, plague and brucellosis germs) in an operational state; a second generation of BWA (for example, Hantan and Japanese Encephalitis viruses) in an operational state; plus a third generation of BWA (for example, SARS, Ebola and Influenza viruses) still under development, in part or entirely. Included are a considerable variety of P&T, both classic BWA and emergent P&T. Anti-livestock and anti-crop BWA are included as well in the Chinese BW inventory. A spectrum of toxins has been weaponized and others are under development as well, and might replace chemical warfare agents (CWA).

Dispersal And Delivery Systems

In spite of lack of concrete information regarding this vital aspect, it is fairly clear that certain RF have fully mastered the aerobiological technologies needed for effective dispersal of BWA, both pathogens and toxins, and probably infected vectors (insects) as well. The quality, extensiveness and characteristics of aerobiological works—including the component of nano-aerobiology—conducted by the related facilities, unambiguously lead to that postulation. They are also able, in all likelihood, to construct the functional conjunction combining dispersal devices, various warheads and delivery systems—including surface-to-surface missiles—in terms of operational biological weaponry.

The concerned system, partially, has the following three components and functions:

1. The Institute of Microbiology and Epidemiology in Beijing, which is responsible for developing dispersal systems at the laboratory level.
2. The Beijing Huifenglong Biotechnology Development company in Beijing, which is apparently responsible for technical upgrading and production of instrumentation for laboratory and field tests.
3. The Institute of Medical Equipment in Tianjin, which seems to be involved in field tests as well, presumably with live, virulent BWA, in addition to published studies with model/stimulant bacteria and viruses.

As mentioned earlier, another important category of facilities that is not actually inquired into in the present study (due to lack of relevant publications) comprises the five corporations administered by COSTIND and/or SASAC, which deals with warheads and delivery systems, at large. It is assumed that part of those corporations are engaged in development and production of warheads and delivery systems for BWA as well.

Several pieces of information independently refer to dispersal devices, warheads and delivery systems, somewhat more specifically, as follows.

As mentioned, in its *Chemical and Biological Defense Program Annual Report and the Chemical and Biological Defense Program Performance Plan* for 2001, the US Department of Defense contended that 'China possesses the munitions production capabilities necessary to develop, produce and weaponize biological agents'.[41]

Warheads containing bacterial BWA, specifically smoke-type (probably aerosol) bombs as well as paper canister-type containers, are produced in China by a facility called 'Yan'an Bacteriological Factory'.[42]

By 2010, China was predicted to have cruise missiles possessing some stealth capability with biological warheads, according to a US Department of Defense report.[43]

Collectively, it can be concluded that China is capable of producing effectual and operational BW warheads and delivery systems, and that it has most probably implemented this capability in actuality, so as to form a deployable BW arsenal.

Estimate and Concluding Remarks

This study covers China's BWP, with special reference to BW capabilities that exist in facilities affiliated with the defence establishment and the military. Subsequent to discussing historical and geostrategic factors,

China's attitudes in relation to the BWC, the rise and persistence of China's BWP and the present relevant administrative system, the functional system has been looked into in detail. For that purpose, 19 facilities affiliated with the defence establishment, 34 military facilities (affiliated with the PLA; either owned by or integral to the PLA) as well as a sample of 12 civilian facilities were reviewed and profiled.

The outcome of that analysis points at 12 facilities affiliated with the defence establishment (governmental defence facilities), plus 30 facilities affiliated with the PLA, that are involved (whether somewhat or largely) in research, development, production, testing or storage of BW. This huge alignment might be regarded as superfluous, ostensibly; yet, considering the magnitude of the Chinese state, its military-oriented potency, its technological ambitiousness and its past, lasting inclination to follow military concepts and programmes of the then USSR (with its enormous BW alignment[44]), the overall derived picture of the Chinese BW-related alignment is not at all surprising.

The structure of the latter is as well outstanding, comprising—beyond the differentiation between facilities affiliated with the defence establishment and facilities affiliated with the PLA—various interlinked sub-systems that follow a domestic, strategically designed concept. In addition to organizational and geographical considerations, that concept is presumably shaped by a methodological approach aiming to mask, conceal or mislead—whether elegantly or heavily—as to the essence, affiliation or modus operandi of at least part of the mentioned facilities. This line is observable with regard to some of the sampled civilian facilities, too, and is conceivably reckoned to be well crystallized. Within the framework of the available open information, the existence of such line cannot be proved; it is supported mainly by indirect evidence.

Albeit postulated independently, such covert framework applied by Chinese apparatuses within the sphere of BW stands in conformity with repeated accusations made throughout the 1990s, and later on by the US intelligence community and related American administration organs, contending that an active BWP, with existing BW arsenal, is being maintained in China—this being the case in spite of the fact that China joined the BWC in 1984. The accusations made by the US intelligence community persisted much beyond 1984, while China was consistently denying ever running a BWP at any point of time. It seems as if those accusations relied on sound intelligence, and that the alleged BW programme and arsenal did exist, and have been retained intact—

and currently upgraded—until present by China. Soberly, China chose to totally deny a BWP, rather than acknowledging it and thereafter being compelled to consequently demonstrate the elimination of its programme. Such rationale was successfully adopted for many years by USSR, and was eventually refuted thanks to the geopolitical shifts that took place in USSR, towards and subsequent to its disintegration.[45]

One major factor utilized by China within that context is 'dual-use' biotechnological and biomedical disciplines. Sophisticatedly vague at times, and at times in a recognizable manner, the various concerned Chinese systems, sub-systems and facilities apply dual-use biotechnological and biomedical disciplines that pertain to both conventional or defensive essentials, but are BW oriented. This line is apparently being implemented in China at both the strategic and tactical levels, namely, within the organizational pattern of the BWP run by China at large as well as in respect to various research, development and production projects conducted for specific objectives. An example, in terms of applicable research, is illustrated in Appendix B, with reference being made to the Second Military Medical University, Shanghai.

Another major element is the prevalent presentation of the concerned Chinese facilities as being ostensibly civilian, or belonging to ostensibly civilian entities. This conduct has further advantage in that it supports the formation of international, fruitful interfaces with technological suppliers and with top scientific institutions abroad. The practice of that conduct is often assisted by Chinese scientists who are situated for a long time, or permanently, at various foreign universities and scientific institutes, particularly in the US. It is directed by COSTIND and by the PLA Military Intelligence Department.[46] The latter department, also known as the Second Department, is China's pre-eminent intelligence agency in regard to collecting foreign high technologies bearing apparent or latent military applications. Based on the limited number of People's Republic of China (PRC) military attachés, the Second Department does not appear to have the overseas presence necessary to be the nation's primary collector of foreign high technologies, but since many Second Department personnel serve undercover as consular officers, the number of collectors may be quite high. Thus, due to close relationship with the consumer, namely, China's military industrial complex and armed forces, the military intelligence is appreciably authorized to plan and conduct operations aiming at obtaining foreign high technologies.[47]

Taking into account the entirety of the R&D activities brought out

by the concerned Chinese facilities, it is fairly evident that a wide range (about three dozens) of various P&T can be developed by those facilities as BW. That range constitutes a large variety of bacteria, viruses and toxic bio-substances, plus several parasites and fungi. Included are lethal, incapacitating, epidemic, non-epidemic and toxin BWA, either intact or genetically modified. Conceivably, toxins might replace part of the Chinese chemical weapons arsenal. It is of note that, practically, research, development or production projects have been systematically conducted in at least two Chinese RF, thereby gaining, both techno-scientifically and strategically, extra validation and backup.

The extent and meticulousness of the published Chinese military R&D activities in the domain of aerobiology—including field tests, inferentially—seem to be far beyond what is needed for merely protective preparedness. This observation applies for bacteria, viruses and toxins altogether. Moreover, those activities appreciably reflect—as far as openly published—a high techno-scientific level attained by Chinese scientists, as well as the BW battlefield environmental circumstances assumed by them, ostensibly within the context of defensive practicing. In that connection, a complex of several facilities in the area of Tianjin appear to be involved in ongoing field tests, with both model and virulent BWA.

This, in conjunction with the evident advanced capacities China has in regard to a large variety of warheads and delivery systems—either conventional and unconventional, in general—particularly within the corporations under COSTIND and/or SASAC, rather lead to the postulation that China likely applies appropriate technologies for the construction and production of effectively deliverable BW. Chinese achievements attained by certain RF in the fields of space microbiology (particularly in terms of microgravity effects), nano-aerobiology and nano-biotechnology are probably significantly contributory in that respect.

All in all, the magnitude, scope and activities of the Chinese BW alignment, as described in this article, might seem exceedingly expedient; yet, in actuality, they are in coherence with the immenseness of life sciences at large, as brought out during the last two decades in particular, worldwide, in conjunction with fundamental strategic faculties marking China. The chances that an outstanding state like China would ignore new avenues of BW designing and deployment—either genetically engineered or otherwise biotechnologically upgraded—are a priori slim, if any, in spite of being a party to and outwardly a big supporter of the BWC. China, in all likelihood, is and will persist as a paramount BW possessor.

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Appendix A

Chinese R&D Funding Resources

A large variety of national and military funding resources support the overall Chinese R&D activities reviewed throughout the present study. The significant funding resources appear to be the following ones (variations in their names are common):

1. Military Basic Research Foundation;
2. Major Scientific Research Project of the PLA General Logistic Department;
3. Key Pre-research Foundation of Military Equipment of China;
4. Military Medical and Technology Twelfth Five-Year Science and Research Key Programme;
5. National 973 Programme of the Mega-projects of Science and Technology Basic Research of China;
6. National 863 Programme of High Technology Research and Development of China;
7. National 853 Programme of Key Technology Research and Development;
8. State Key Laboratory of Space Medicine Fundamentals and Application, Chinese Astronaut Research and Training Center;
9. National Key Subjects of Scientific and Technological Foundation;
10. National Major Special Programme of Science and Technology of China;
11. National Science and Technology Supporting Programme of China;
12. Important National Science and Technology Special Projects for Prevention and Treatment of Major Infectious Diseases;
13. National Key Programme for Infectious Diseases of China; and
14. Genetically Modified Organisms Breeding Major Projects.

Appendix B

The Second Military Medical University, Shanghai

Among the units included in that university are the following:

1. Shanghai Key Laboratory of Medical Biodefense (also named Shanghai Key Laboratory of Medical and Biological Protection);

2. Department of Pathogen Biology and State Key Laboratory for Medical Immunology; and
3. International Joint Cancer Institute (covering toxinological subjects as well).

Listed below are examples of works published by those units.

Shanghai Key Laboratory of Medical Biodefense (also named Shanghai Key Laboratory of Medical and Biological Protection

The human, highly pathogenic, avian-derived H7N9 influenza virus was studied and the plausible binding site change underling acquired infectivity towards man was pointed at.[48]

The process enabling infection by Japanese encephalitis virus (in Huh7 cells) was studied and it was found that association of heat-shock protein 70 with lipid rafts is required for productive infectivity.[49]

A highly virulent fungal pathogen—Cryptococcus—was investigated in diseased patients with meningitis and clinical features were compared about persistent and non-persistent cryptococcal meningitis.[50] Of 106 patients enrolled, 16 were identified as persistent cases. The distinction between persistent and non-persistent cases, particularly considering that this pathogen is a potential BWA, is significant.

Multidrug-resistant *Streptococcus pneumoniae* was investigated, in terms of developing a specific benzoxaborole-based derivative as effective inhibitor against that airborne pathogen.[51]

Department of Pathogen Biology and State Key Laboratory for Medical Immunology

Further work on Japanese encephalitis virus (JRV) was done in that department. Monoclonal antibody against a specific epitope of JEV (a mosquito-borne virus) was experimentally produced, and then administrated into mice, in order to appraise the antibody efficacy to protect against JEV. It was thereby found that protection was attained and that the antibody is useful for JEV diagnosis as well.[52]

Another mosquito-borne disease—Malaria—was studied. Experimental infection of *Anopheles stephensi* mosquitoes with the malaria pathogen, *Plasmodium yoelii*, was conducted. An enriched cDNA pool of the mosquito genes, which up-regulated responsively at the early stage of infection, was obtained, and it was concluded that expression screening against the pool indicated that various biochemical processes and mechanisms might be involved in the response of mosquito to infection.[53]

A chimeric protein of a different species of the malaria pathogen, *Plasmodium falciparum*, was established—at a structural level—as a potential malaria vaccine.[54]

Also, a review article was published by the department, which focused on the methods of isolation and cultivation of pathogenic free-living *Acanthamoebae*,

including sample treatment, culture conditions, passage culture, pathogen detection and maintenance.[55]

International Joint Cancer Institute

The highly potent plant toxin ricin was investigated for its particular toxicity. Mice were randomized into several groups, and intraperitoneally injected with ricin holotoxin diluted in 0.2 ml of PBS (50 μg/kg). The results clearly demonstrated that the flexibility of the a-helix is responsible for controlling the depurination activity of ricin and determining the extent of protein synthesis inhibition.[56]

Botulinun toxin type B was studied in terms of potent neutralization by synergistic action of antibodies recognizing protein and ganglioside receptor binding domain. For cross-protection assays, 100 μg of the neutralizing preparation was pre-incubated with 20 LD50s of four botulinum toxin types, namely, A, B, E and F (provided by Lanzhou Institute of Biological Products), for 1 hour respectively. The mixtures were injected into mice, and the final death tally was determined four days after injection.[57]

Staphylococcus enterotoxin B (SEB) was investigated in terms of the structural basis for its neutralization and specificity against its MHC Class II binding site. Native SEB was used, and recombinant SEB (plus SEA) were expressed in *Escherichia coli* BL21 (DE3) under the induction of isopropyl-b-d-thiogalactopyranoside.[58]

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