

History of Asian Medicine

The “Yellow Rain” controversy: are there lessons from the past?

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A quarter century has passed since the “Yellow Rain” biological warfare controversy in Southeast Asia had become a major news item worldwide. The debate whether or not a biological warfare weapon was used at that time has never abated and was the subject of a recent PhD thesis.

Starting in the late 1970's, persistent reports of chemical attacks appeared originating from Hmong resistance forces in Laos fighting the Vietnamese and Pathet Lao forces. Soon, similar reports came from the Khmer Rouge as well as from the anti-communist Khmer Peoples National Liberation Front who also were engaging the Vietnamese army as well as the Khmer Rouge. The Soviet-backed Vietnamese army was held responsible for use of chemical and/or biological agents. Attacks were said to be in the form of gas or “yellow rain”-like toxic spray delivered by aircraft or artillery. Many rapid and more delayed deaths of domestic animals as well as humans were said to have resulted. The initial reports were in the form of interviews of refugees, usually originating from relief workers, missionaries and international news-service reporters. No reliable witness interrogation by professionals or forensic laboratory investigation was conducted and no “smoking gun” was found. Much of this seemed a repetition of similar accusations directed previously at the Soviets in Afghanistan. It was similar to what the US had been accused of during the Korean War and reminiscent of the more recent accusations against Saddam Hussein in Iraq which helped start the Iraq war. Chemical and biological weapons were banned by the Geneva Convention of 1925 which was signed by a majority of countries. It seems that this convention had been largely ignored. The author believes that valuable lessons can still be learned from reviewing these events.

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Though the use of poison gases is a historical fact during several prior wars, it was during the Korean War (1950-53) that the Soviet Union, North Korea and, the People's Republic of China first made serious claims that biological warfare was carried out by the United States of America against North Korea. However, using bacteria and other biological agents in war was not new. Chemical weapons were used in World War I by all sides. German agents tried unsuccessfully in 1915 to introduce biological warfare in the form of glanders and anthrax bacteria to infect horses and mules destined for Allied armies in Europe. They may also have tried to infect St. Petersburg in

Russia with plague [1]. This was, however, not the first attempt to bring infectious diseases to an adversary in war. Medieval armies tried to create epidemics by “poisoning wells” with cadavers of plague victims and by catapulting rabid dogs into besieged cities. Blankets infected with smallpox virus were given to Indian tribes during the American colonial period with devastating results. It is amazing that there was little, if any, use of poison gas during the Second World War, even though all parties had huge stores of such gases as well as the delivery munitions. One reason for this may well have been the fear of unleashing stockpiled deterrents to be used for retaliation by the other combatants. It has also been said that Adolf Hitler, who may have been exposed to poison gas on the western front as a young soldier in 1915, had developed an aversion to gas warfare. This did not stop him from gassing

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defenseless millions of Jews, Poles, Russians and Gypsies in concentration camp gas chambers. Poison gases were extensively and effectively used in the late 1930's by the Italians in Ethiopia and by the Japanese in China. Lieutenant General Shiro Ishii, a microbiologist from Kyoto University School of Medicine, Japan, established "Unit 731" in Manchuria, China for developing bacteriological weapons of mass destruction for the Imperial Japanese Army. The Unit 731 was divided into eight divisions; one was devoted to research on live human subjects. It employed up to 3,000 staff and had satellite facilities in other parts of China. Their main focus was on bubonic plague, cholera, anthrax, typhoid and tuberculosis but other microbes were also studied. Dr. Ishii and his colleagues were successful in the laboratory and experimented extensively on humans, virtually all of whom died during experiments or were executed later. At the end of the war, General Douglas MacArthur, the "proconsul" of Japan during the occupation, secretly granted immunity to the physicians of Unit 731 in exchange for providing the United States with their extensive knowledge of biological warfare technology [2-4]. The United States believed that this information was immensely valuable because allies had never conducted or condoned such experiments on humans

due to moral and political revulsion. The United States also did not want other nations, particularly the Soviet Union, to acquire Dr. Ishii's data on biological weapons and the potential military benefits which might be derived [5, 6]. Nazi-German physicians, who carried out human experiments on prisoners during World War II, were not as lucky as those from the Japanese Unit 731. Several were hanged by the Allies at the end of World War II. It was said that their experimental data were crude and of no interest to the victors. Data on duration of survivable cold-water exposure of fighter pilots from studies on concentration camp victims were, nevertheless, later used in Allied military manuals. General MacArthur's amnesty allowed Dr. Shiro Ichii, whom we may consider the father of modern biological warfare, to die peacefully at his home of throat cancer in 1959 (**Fig. 1**). Interestingly, it was his "second death". As part of the 1945/46 secret amnesty negotiations with General McArthur, his death was publicized in the Japanese press and a funeral was staged in his home town [7]. His legacy continued in that American forces during the Korean War were accused of having Dr. Ishii's technology for waging biological warfare against North Korea and China [7]. Americans were said to have sprayed plague, anthrax, scrub- and murine typhus bacteria as



Fig. 1 Dr. Shiro Ishii, Commanding General of Unit 731 in Manchuria, China; the "Father" of modern biowarfare. He was never indicated or held responsible for his actions and died peacefully in 1959. (Picture from *Wikipedia, the free encyclopaedia*).

well as Japanese encephalitis virus onto soldiers and the North Korean population. Reports with graphic testimonials appeared in the international media. Elderly (but still internationally respected) Chinese scientists and quite a few western academics started to support these claims. The US Army laboratory in Tokyo, a possible recipient of Dr. Ishii's secret data, was said to have grown and formulated the organisms for dispersal from aircraft and releasing artificially bred- and infected-mosquitoes and fleas from Ishii-designed bomblets. Strangely, some of this was said to have occurred during the fall and winter. These news reports, released originally by the Soviet Union and the People's Republic of China, found many believers and were repeated extensively and uncritically by international media. The author questioned an old friend, Dr. Fred Prince, later director of the New York Blood Center and co-discoverer of the Australia Antigen, who was a senior scientist at the US Army laboratory in Tokyo during the Korean War. He absolutely denied that there was any basis for them. The same question was addressed in 1985/6 to Professor Konosuke Fukai [8] of Biken Institute (Research Institute for Microbial Diseases of Osaka University), who was a colleague of Dr. Prince at the US Army Laboratory. He stated emphatically that the allegations were "rubbish" and that they only carried out biological warfare defensive research and acted as a diagnostic reference laboratory for US forces in Asia. It should be noted that all the diseases such as plague, anthrax, typhoid and typhus as well as Japanese encephalitis that were claimed to have been introduced artificially to the region, had been endemic and occasionally epidemic on the Korean peninsula and China for decades. It is very likely that they flared up during the catastrophic war that engulfed the entire peninsula destroying infrastructure, food supplies and what limited public health installations had been present. A book written by Canadian and American historians publicized this "war-crime" by UN forces during the Korean war as late as 1999 [9, 10]. The book was widely read, believed and referenced. Amazingly, the Munhwa Broadcasting Corporation of South Korea produced a documentary in July, 2000 which reported these old allegations. Chemical weapons were used effectively in Yemen in the early 1960's by Gamel Nasser's Egyptians and by the Soviets in Afghanistan in the late 1970's. Russia was accused of having used fungi-derived mycotoxins as well, but no reliable evidence for the use of such

biological agents was ever presented even though it is known that Russia was engaged in research and manufacture of a variety of biological warfare agents [11]. President Nasser had good access to the Soviets at that time and reports of his forces using chemical but not biological agents in Yemen have been confirmed by UN observers [1].

The Vietnamese war and chemical and biological weapons

The next accusations that a belligerent power had introduced biological and chemical weapons involved the Soviet Union, North Korea and People's Republic of China as perpetrators. US Secretary of State Alexander Haig reported in a speech in Germany in September, 1981, and later in a report to the US Congress, that Soviet-backed Vietnamese forces were using biological toxins as a weapon against Hmong villagers in Laos and Khmer Rouge soldiers in Cambodia. An abundance of reports from victim interviews, debriefings of Vietnamese defectors, collection of samples from forests followed [12, 13]. However, no acceptable forensic study was carried out by independent qualified investigators and many samples, collected in unscientific manners, were passed through many hands and by persons who were consumed by political or occupational bias. The international media soon took notice of these reports as newsworthy and scientists, who supported these allegations on the basis of the reports or a quick visit to Asia, were readily found around the world. The unpopular nature of the war and emergence of an active peace movement helped dissemination. The Yellow Rain toxin, claimed to have been responsible, was thought to be trichothecene, a product of *Fusaria fungi*. Confirmation was thought to have been obtained by several chemical analyses of samples. No comprehensive scientific study of natural *fungi* and trichothecenes in the local environment were done except for two small-scale studies of Thai soldiers in Bangkok who showed no trichothecenes and of soldiers serving in rural Thai provinces who were found to have low levels of the mycotoxin in serum [14]. An investigative reporter, who grew up in Asia, wrote a book about these events in 1981, and was inclined to believe that biological and chemical agents had been used by Vietnamese forces in Laos and Cambodia [5]. *Fusaria fungi*-derived toxins of the trichothecene family had a long history in several parts of the world. They grow on grains and had caused epidemics

from eating stored staples with many deaths in Siberia where grains had been stored improperly over the long winter and food was in short supply and often improperly handled [5]. The disease caused by these toxins was called alimentary toxic aleukia as symptoms were largely due to bone marrow suppressive manifestations. Agricultural outbreaks were also reported from Europe and included a large turkey farm-dying in England. It is no surprise that much research by agricultural as well as public health scientists then resulted in many parts of the world including Western Europe, the Soviet Union, Canada and the United States. They focused on prevention of such food-borne epidemics and preceded the accusations from Southeast Asia [15-18]. A senior Soviet military microbiologist, Colonel Ken Alibek, working for years on biological warfare agents, moved to the United State and wrote a fascinating book. There is no mention of *Fusaria fungi* or trichothecenes in any of his writings that discussed even more remote potential agents for biological warfare that were under study or developed in the Soviet Union. This does not contradict the proven fact that academic and agricultural institutions in the Soviet Union studied mycotoxins extensively as a public health menace.

Illness and deaths from *Fusaria* mycotoxins are caused by the cytotoxicity of these agents (of which

there are several, but T2 (diacetyoxyscirpenol) is the most cited). They act on rapidly reproducing cells. Bone marrow and gut tissues are the most susceptible. A large intake could be rapidly fatal, usually by causing shock and multisystem failure. Bleeding manifestations may appear later. Some trichothecenes were also found to be neurotoxic and could be manipulated to make them more absorbable by skin [19, 20]. Some of the clinical descriptions of symptoms obtained from villagers and defectors are consistent with high dose trichothecene poisoning but could also have been caused by several current chemical warfare agents and natural diseases (dengue hemorrhagic fever, leptospirosis and others). *Fusaria* were common among orchid plants in Thailand (Professor of microbiology, Dr. Kachorn Pranich, personal communication). *Fusaria* species keratitis and invasive fungal infections have been reported worldwide, including from Hong Kong, Singapore and Thailand [21, 22]. Many species of *Fusaria* can be readily cultured from the environment [22]. The author repeatedly requested modest funding for a “background” *Fusaria* study, using a Thai mycology and toxicology expert from Siriraj Hospital, Thailand. It was denied by Washington DC, even though US Ambassador John Gunther-Dean strongly supported it.



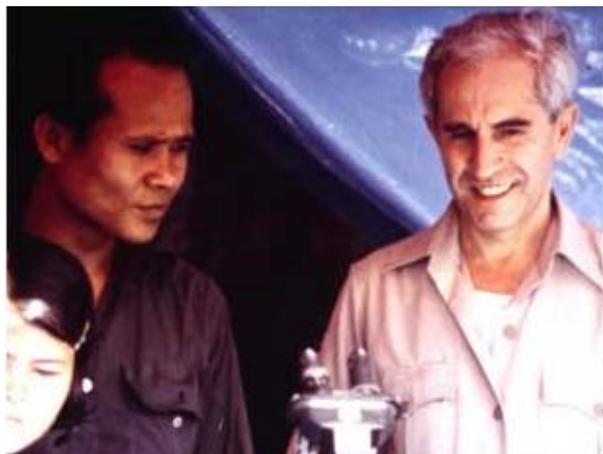
Fig. 2 Meeting at Siriraj Hospital at Bangkok to discuss common issues of those troubled times. From left: US Ambassador John Gunther-Dean, Professor Vikit Viranuvati, Dr. Henry Wilde, Professor Yachai Na Songkhla. Presiding: Professor Pradit Chareonthaitawee (Rector of Siriraj Hospital).

The author, then a US Embassy officer, spent one year part-time investigating reports of biological warfare in the field. Interviews were conducted with newly arrived refugees from communist-controlled Laos. The stories were all similar and were told as personal experiences by Hmong villagers as well as town dwellers, unlikely to have been in regions targeted [23]. It is noteworthy that by that time reports of chemical and biological warfare had appeared extensively in the local English, Thai, Vietnamese and Khmer languages. Refugees usually reported that a plane flew over the village and spread different colored "rain" (mostly yellow) which caused very early deaths among livestock and humans. Deaths of humans and livestock were said to be from bleeding, diarrhea, shock and severe delayed skin rashes. The author then spent almost one week looking at possible toxin victims in a Khmer Rouge military field hospital and village on the Cambodian side of the Thai border near Aranyaprathet (see **Fig. 3(A-C)**). We were met there by Khmer Rouge "Secretary of State", Chorn Hay and his deputy for "Science and Technology", Thium Mumm who gave us blanket authority to investigate poisonings and converse with victims and field hospital staff [24, 25]. All patients were presented as poisonings and, examined by the author in the presence of the Khmer camp physician, Dr Map (graduate of Phnom Penh Medical School in 1969) as well as Cambodian speaking US Embassy officer, Timothy Carney. They were found to suffer from a variety of clinically diagnosable infectious or parasitic illnesses (hepatitis, probable liver abscess, scabies, tuberculosis, malaria and probable scrub typhus). Interestingly, it was obvious that Dr. Map agreed with the author's clinical impressions but had been ordered by his Khmer Rouge political boss to produce poisoned patients. Several of the more mysterious patients were transferred to Siriraj Hospital at Bangkok. None were found to be intoxicated and all had a final definitive diagnosis unrelated to chemicals or toxins. We had also been told that there was a spring in the jungle where several Khmer Rouge soldiers died after consuming the water. Timothy Carney and the author insisted on being taken there, but were told it was too dangerous. We later received a bottle filled with water said to have come from the spring. It was sent to the forensic laboratories at Siriraj Hospital with a duplicate to Fort Detrick, USA. Both reported the presence of cyanide. Several extensive reports were sent to Washington DC, regarding these efforts by the author and colleagues.

Some have since been declassified and have been used in several recent publications [24, 25]. Several samples from victims were sent to the laboratory of Professor CJ Mirocha at the University of Minnesota, USA. They were reported to contain trichothecenes. However, his results were not confirmed by repeated testing at several laboratories in the US and abroad. The Minnesota laboratory had previously handled large amounts of trichothecenes in food safety and agricultural investigations and contamination of specimens was considered likely [26-28].

As time went on and no clear evidence could be produced, even initial supporters of the "Yellow Rain" claim started to fade away [28, 29]. This was accelerated by reports from Professor Matthew Meselson from Harvard University, Thomas Seeley from Yale University, and Pongthep Akkratanakul (an expert on Thai bees) from the Faculty of Agriculture, Kasetsart University at Bangkok. They found that yellow rain samples consisted mostly of bee feces. It was also found that they contained pollen of many different varieties of plants native to Southeast Asia. This made it even more unlikely that Yellow Rain was an industrial product manufactured as a substrate for mycotoxins [30-33].

A report from the People's Republic of China dated 1977 of pollen analyses of "Yellow Rain" samples from Northern Kiangsu Province, also found that they were from collective defecations of honey bees and seeds from local plants [31]. The Chinese villagers exposed to these yellow droplets experienced panic, assuming that they were toxic and this prompted the scientific study by Chinese scientists. The author then became convinced that he was looking for ghosts in searching for Yellow Rain toxins and withdrew from this part of his duties with support of his boss, US Ambassador John Gunther-Dean. He was replaced by a full-time well-qualified US Army Medical officer who continued the futile search to find the "smoking gun" for one more year. About that time, there also appeared stories from the field that our then adversaries in Vietnam started to use yellow artillery marking powder captured from US Forces and designed to be sprayed from aircraft to mark enemy locations as artillery targets during the Vietnam War. Spreading such yellow dust over a Khmer Rouge or Hmong military encampment never failed to cause panic as the "Yellow Rain" story had become generally known via radio on both sides of the fronts. It thus became an effective "psychological weapon" for



(A)



(B)



(C)

Fig. 3 At a Khmer Rouge field hospital inside Cambodia. (A) The author with the Khmer camp doctor. (B) The camp physician Dr. Map and the political head of the hospital. Pictures were taken inside the 30 bed bamboo ward. (C) One patient who was presented to the author as a victim of yellow rain toxin. He was edematous and had many infected mosquito bites. The author's clinical diagnosis was nephrotic syndrome, possibly from chronic malaria. The Khmer doctor agreed after we had a discussion and found four plus proteinuria.

Vietnamese field commanders. Amazing is that this story never died and trichothecene biowarfare is still listed in text books as a historical fact [1]. A recent doctoral thesis by Rebecca Lynn Katz at Princeton University, USA, claimed to prove that trichothecenes were used in Laos and Cambodia. She presented no new scientific proof, but her thesis was accepted in 2005 for a PhD degree [34].

What can be concluded?

Reports from victims interviewed by the author were impressive. However, it must be known that they were obtained after extensive publicity in the press and radio in local languages throughout the region. It can never be conclusively established whether they were initially based on real facts. The author often had the impression that he was told what the interviewing person wanted to hear. All of the persons that he interviewed in refugee camps near Udontani, Thailand, already knew of the Yellow Rain issue from media and other camp inmates. Many were hoping for early immigration to a western country and aimed to please the American officer who had many questions and often was handing out food parcels. One theory is that the Soviet Union and their allies did some experimentation with some sort of toxins as biowarfare agents as well as with traditional chemical agents, but abandoned this later when serious investigations and condemnations by the international community commenced. The author considers this rather unlikely. No toxins were ever identified in a weapon or at high levels at sites of supposed attacks. Trichothecenes have, however, been identified in the environment where *Fusaria fungi* are virtually everywhere. A Thai border police officer at the camp where the author interviewed recently-arrived Hmong refugees from Laos, asked why the interest in Yellow Rain when these poor people had just been strafed by machine-gun fire. About the same time, a young American ex-special forces veteran came under my professional care. He had volunteered to continue his personal war with the North Vietnamese by joining the anti-Vietnamese Khmer Peoples National Liberation Force (KPNLF) under Son San as a weapons expert. They were fighting both sides in a losing battle near the Thai-Khmer border, and media had reported that they had also been victims of "Yellow Rain". The young man was desperately ill with malaria, malnutrition and cellulitis of his leg. The author had some three week's contact with him as

his physician as well as host at his home in Bangkok. He denied that any chemical or biological attack had occurred during his almost one-year stay with the KPNLF. This information was reported by several cables to Washington DC.

It is the author's view that the honey-bee swarms communal yellow defecations of Professor Meselson and his colleagues [26] are one explanation for "Yellow Rain". US origin and Vietnamese-captured yellow artillery marking dye may well have been another. It has not been proven and probably never will be whether there was an actual effort to use fungal or other toxins as a biological warfare agent in Southeast Asia. There may have been isolated chemical agents used against the Khmer Rouge and Hmong, but even this remains unproven. Vietnamese forces inherited a large captured supply of American anti-riot non-lethal gases that may have been used and then reported as potent poison gas attacks. A recent publication by a former CIA (Central Intelligence Agency, USA) operational officer, who also worked on the "Yellow Rain" issue in Thailand full-time for over two years at the same time as the author, discussed his experiences in great detail. He had extensive contacts with Vietnamese prisoners and military defectors. One was a senior Soviet-trained chemical and biowarfare expert. He was extensively debriefed, repeatedly polygraphed, and stated that there was no chemical or biological weapon used by the Vietnamese army. He concluded that the Yellow Rain story was mostly the result of fabrication by intelligence peddlers who populated border regions and refugee camps. Their information was amplified by gullible relief workers, missionaries, inexperienced interviewers and, finally, politicians who found this information useful for their cause or career advancement [35]. To prove that something does not exist, is more difficult than to confirm events that did.

What came next?

There was a claim that in Iraq, Saddam Hussein possessed chemical and biological warfare weapons that would be used in a future war. He was also reported to be constructing nuclear weapons. It is a historic fact that he used poison gas against Kurdish villagers and also in his war against Iran. Virtually the whole world considered him a murderer and dangerous psychopath. However, the assertion by the US government that Saddam Hussein was in possession, or close to it, of biological mass destruction

materials, was not based on any evidence and none was ever found. UN staff and a battle-hardened US Marine officer assigned to an international investigative team had so stated in several reports prior to the onset of war. Their impressions were based on actual observations and local information by professionals [36]. They were mostly ignored and rumors from intelligence peddlers were used to justify a war. Perhaps, it will some day become known whether this was a deliberate effort to deceive public opinion in favor of the invasion of Iraq, or one based on inaccurate information from other sources. Nevertheless, it seems that we are unwilling to learn from history to rapidly and scientifically investigate similar future assertions, and to determine whether they are correct or efforts at deception that have been embellished by the media's eagerness to report what they consider newsworthy. It is likely that future combatants will again be tempted to utilize chemical and biological weapons or use rumors and false or planted intelligence of such weapons use for propaganda purposes. It might be appropriate to plan for internationally acceptable means to rapidly investigate and verify any such claim. This should be done by recognized and academic scientists with appropriate forensic training who have no ties to the combatants. It must commence soon so that forensic documentation is still possible while quality-evidence can be collected and has not yet been tampered or degraded. Early involvement by the United Nations might be one approach. If claims of use of outlawed chemical or biological weapons have been documented, referral to the International Court at The Hague for prosecution of the perpetrators for crimes against humanity might be warranted.

The author is a retired Senior US Foreign Service Officer. He has no conflict of interest to declare. He is grateful to several of his old American and Thai colleagues who have made helpful comments based on their own experiences.

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