The Possible Use of Chemical Warfare Agents in Southeast Asia

by
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Background

As early as 1976, reports of the use of lethal chemical weapons began to emerge from Laos; similar reports started to come from Kampuchea in 1978, and since 1979 from Afghanistan, but the early reports were fragmentary and not always consistent. In the fall of 1975, a U.S. Army medical team visited Thailand to conduct refugee interviews, and the team established that three basic groups of symptoms and sign occurred after attacks: skin burns, bleeding and death in spasms and convulsions[1].

The United States made repeated presentations to the world press and to the United Nations and, after circulation of a comprehensive documentation to UN member states, a number of nations suggested that an impartial investigation of the alleged use of chemical weapons be carried out. To this end, in December 1980, the UN adopted a resolution (A35/144C) establishing a UN investigation by a group of technical experts.

On September 13, 1981, the U.S. Secretary of State, General Haig, charged that the U.S. had obtained physical evidence of the use of lethal mycotoxins in Southeast Asia, however, the UN group of experts which visited Thailand in November, 1981, and interviewed refugees and eyewitnesses, was unable to reach a definite conclusion. The Report of the UN Group of Experts[2] stated also that the group had been unable to carry out all the actions it had intended, such as on-site visits in Afghanistan, Laos and Kampuchea. Consequently, the UN adopted a resolution (A/36/96C) to extend the mandate of the Group of Experts for another year.

The U.S. Charges have implications that extend beyond the particular horrors they allege: the user(s) of mycotoxins as chemical warfare agents may be in violation of the 1925 Geneva Protocol[3] and/or the 1972 Biological and Toxin Weapons Convention[4].

The U.S. Charges

In a report to the Congress of the U.S. by the Secretary of State, A.M. Haig, in 1982[5], prepared from information made available to the U.S. Government since 1975, the U.S. charged that Lao, Vietnamese and Soviet forces have employed lethal trichothecene toxins[6] and combinations of chemical agents. Trichothecene toxins have been identified in a number of samples[7]. Additionally, the levels of the toxins found were higher than one could expect from naturally occurring mycotoxins.

Doubts with Respect to U.S. Charges

Since the U.S. allegations have been made public, there has been no lack of criticism and doubts[8]. Skeptics say that certain fungi, such as *Fusarium* spp., capable of producing trichothecenes, are likely to occur throughout the world and that there are, in fact, reports of finding trichothecenes in countries with warm climates, such as India[9]. Others point towards the fact that trichothecenes are relatively weak poisons and need some time to cause effects, and therefore would not make much sense as a chemical weapon[10].

Canadian Aspects

Canada's interest in the matter covers the broad spectrum of not only humanitarian aspects but also of international law and procedures. The Department of External Affairs decided, therefore, to commission an independent Canadian investigation. To this end, the author was asked to perform such a study, and he visited Thailand from February 12 to 28, 1982. The author conducted on-site inspections close to the Thailand-Kampuchea and Thailand-Laos borders, interviewed victims and refugees, received reports from various scientists, physicians and Thai authorities, and investigated the general disease pattern in Thailand, with particular reference to mycotoxicoses. The final report[11] was presented to the UN by the representatives of the Canadian government. Two further Canadian documentations[12] were submitted later.

General Situation in Southeast Asia During February, 1982

In Kampuchea, the Vietnamese-Kampuchean troops made a concerted effort to break down the remaining Khmer Rouge resistance. On February 13, 1982, "the Vietnamese forces fired artillery shells with gas canisters into areas around Khao Din (Kampuchea)."[13] Two days later (Feb. 15, 1982), five Thai border patrol policemen were killed during a clash with about 300-400 intruding Vietnamese soldiers inside Thailand[14]. On February 19, 1982, an airplane, coming from Kampuchea, sprayed a light yellow chemical dust over Ban Saptali and four other villages in the Pang Namron district (Thailand). The material was reported as "unlikely Yellow Rain" after preliminary investigations[15]. Along the Thailand-Laos border, no particular incidents took place, but refugee reports indicated that chemical attacks were continuing inside Laos.

Interviews with Victims of Alleged Chemical Attacks

A group of seven Khmer Rouge soldiers, subjected to an attack with 105 mm artillery shells on February 13, 1982, inside Kampuchea, was interviewed on February 19, 1982. The symptoms experienced were described as: "burning sensations in the eyes, vomiting, dry throat, shortness of breath, burning sensation in breast and abdomen." None of the casualties died, and the seven were on their way to recovery, except for one who was apparently suffering from a severe case of malaria.

Two Hmong fighters were interviewed in the Ban Vinai refugee camp, close to the Laos border, and a collection of transcripts of earlier interviews with a number of other victims in the camp were reviewed. The essential items in these reports can be enumerated. First, up to 18 gas attacks on one and the same village (that is, Phan Meum, north of the Nam Ngeum Dam in Laos) were reported. Second, the chemicals, typically, were sprayed from low flying aircraft. Third, within hours, people began to be sick (continued diarrhea, vomiting and hemorrhaging) and those who died in the following days were mainly children and old people. As far as animals were concerned, chickens and dogs were said to die first (up to 10 days), buffaloes and pigs a little later (13-14 days, particularly after eating leaves with "spots" on them). Plants were reported to turn yellow within 10-14 days. Finally, months later, many Hmong who escaped to Thailand were still suffering from respiratory problems. Medical examination revealed no signs of tuberculosis or other known causes of respiratory disease.

When comparing the details given at different dates by the same witness, and when looking at reports from other incidents, one cannot help but notice many inconsistencies. This could be due to difficulties arising through the translation by interpreters, or it could be due to different emphasis on questions posed by the interviewer(s), plus failure of memory and/or a tendency to make a story more impressive. On the other hand, it is difficult to overlook the principal facts and sequence of events: i.e., accounts of attacks, whatever the colour of the "gas" described may have been, with their subsequent suffering and death of humans. Various types of disease symptoms, mainly concentrating on vomition, diarrhea, skin affections and finally, the death of various forms of life (man, animals, plants)—these aspects were always represented.

In a recently released epidemiological study[16] of the survivors of attacks on selected villages inside Thailand, it was found that eye, upper respiratory tract, lower respiratory tract, central nervous system, gastro-intestinal, musculo-skeletal, skin and functional symptoms were present in over 90% of the people interviewed. These symptoms were quantitatively different, but qualitatively the same as those described by refugees reporting direct attacks.

Results

Evidence suggesting that chemical warfare agents were used

The reports from refugees who were interviewed, the written records of patients and eyewitnesses, together with numerous other reports of the alleged use of chemical warfare agents, attest to the fact that "something is going on." Although one has to take into consideration the possibility of exaggeration in some of the refugee reports, and, further, that some part or all of the "eyewitness reports" may be fabrications under the influence of hearsay and political pressure, one has to give serious attention to the apparently never-ending flow of reported incidents. It appears highly unlikely that the essentials

of the reports are all the products of imagination, fabrication or propaganda.

There is no indication of natural occurrence of diseases in Thailand, and presumably in the neighbouring countries which share the same climate and general living conditions with the Thai, that affect, at the same time, all types of life be it human, other animal, birds and plants[17]. Therefore, it is highly improbable that the events reported by the refugees could be due to natural circumstances.

Types of chemical or biological warfare agents that may have been used

Although certain reservations are in order, it is possible to categorize the agents that have been used into three broadly defined groups on the basis of the numerous reports. The colour codes may not be taken as completely reliable; they simply serve to make distinctions between different types of agents. The following types of agents have been reported:

"Yellow" — causes skin rashes, vomition, difficulty of breathing, hemorrhages, and eventual death of humans, animals and plants;

"White" — causes headaches, blurred vision, vomition and rapid death of humans and animals;

"Green" — causes difficulty of vision, numbness and a feeling of general disorientation in humans.

The author is neither experienced nor qualified to comment on commonly known chemical warfare agents[18] or on the agents that have been described as "white" and "green", but the "yellow" agent causes symptoms that have a certain similarity with diseases caused by mycotoxins of the trichothecene variety. Other sources[19] have attempted similar classifications, suggesting that the compound with the lowest lethality ("green") may be an unknown "knock-out gas".

Evidence suggesting that mycotoxins may have been used

Many symptoms described in the eyewitness reports and in earlier documentations are suggestive of trichothecene mycotoxicosis. However, when comparing the symptoms and other information on naturally occurring Alimentary Toxic Aleukia (ATA)[20] and *Stachybotryotoxicosis*[21] with the features described by witnesses of the alleged chemical attacks, it is evident that there are more similarities between Stachybotryotoxicosis and "Yellow Rain" than between ATA and "Yellow Rain."

ATA is a disease due to ingestion of trichothecenes, and it takes time for most symptoms to develop. Stachybotryotoxicosis, on the other hand, can cause rapid death. Therefore, the reported occurrence of immediate death after "Yellow Rain" attacks are not consistent with the assumption of application of T-2 toxin or other non-macrocyclic trichothecenes, unless one would assume simultaneous application of a suitable substance facilitating entrance of the toxin into the body. So far, no reports on finding a vehicle have surfaced,

but it is worthwhile to mention that most victims of attacks reported that they "smelled garlic" or had some other abnormal taste sensation. The literature is replete with descriptions of abnormal odor and taste sensations, particularly garlic, and nausea vertigo and difficulties with vision in patients treated with DMSO[22].

With respect to macrocyclic trichothecenes, it has to be said that there are, so far, no reports of finding this particular group of trichothecenes.

The hypothesis that trichothecenes have been used in gas attacks is supported by the information released by the U.S.[23]. Not only were relatively high levels of trichothecenes found in samples from locations where gas attacks occurred, it has also been reported that a metabolite of T-2 toxin, the deacetylated T-2 toxin form, called HT-2 toxin, was found in the blood of victims[24]. In other samples from attacks in Southeast Asia, high concentrations of vomitoxin, TO2 toxin, diacetoxyscirpenol (DAS) and zearalenone have been identified[25]. The levels reported are unusually high when compared with findings of trichothecenes in mouldy feeds[26]. Naturally occurring levels are around 2ppm (parts per million), the largest quantity ever found to occur naturally being reported as 71.5 ppm of T-2 toxin[27]. Under laboratory conditions, up to 2,250 ppm[28] of trichothecenes and more can be produced readily.

The question of "natural background" levels of mycotoxins and toxigenic fungi in Southeast Asia has been raised frequently in the discussion of this topic and to find an answer was one of the objectives of this Canadian study.

The Thai's are quite aware of the potential natural existence of mycotoxins in their country. The occurrence of aflatoxin is well documented since "Udorn Encephalopathy" (Reye's Syndrome) in Thailand was associated with aflatoxin in 1971[29]. Outbreaks of aflatoxin-poisoning in pigs in particular are a common experience[30] and a vast number of Thai foods have been sampled for aflatoxin[31]. The nephrotoxic ochratoxin is also fairly well studied[32], and the occurrence of zearalenone, an estrogenic mycotoxin, is suspected[33].

There are no indicatations that the Thai's have been looking for trichothecenes in particular, but physicians and veterinarians who are aware of the diseases caused by these toxins[34] have yet to see a natural disease outbreak.

Vegetation and soil samples collected by the author close to the Thai-Kampuchean and Thai-Laos borders did not contain any mycotoxins[35], but various fungal species were isolated, such as *Fusarium equiseti, F. moniliforme, F. oxysporum, F. semitectum* and *F. solani.* These results agree well with more extensive, earlier investigations in this region[36]. The findings indicate that potential producers of trichothecenes do exist in Southeast Asia, but neither naturally occurring diseases due to trichothecenes are described or seen, nor are there any detectable levels of toxins in the environment.

"Yellow Rain" events inside of Thailand

A number of small villages, amongst them Ban San Tong and Ban Sub Tha Man, close to the Kampuchean border, were sprayed by an airplane on February 19, 1982[37]. While the author was in Thailand, he was not able to visit this area, but he received a leaf, from an unidentified tree, with a yellow "splash" on it. Approximately four weeks later, members of the Canadian Surgeon General's staff conducted an on-site epidemiological study[38]. The team found out that subsequent to the aircraft incident, yellow spots had also appeared overnight on several occasions during February and March, 1982. The prevailing wind during the dry season (February-June) is from the east, and it was assumed that some of the material might have been blown over the border when attacks occurred inside of Kampuchea. The epidemiological investigation revealed an uncommon level of illness in people of the villages affected, coinciding with the day(s) of spraying. Abdominal pain was the most common complaint, in addition to non-specific symptoms, i.e., dizziness, weakness, etc. Bleeding was not a major symptom. A water buffalo, seven days after the incident, refused to eat grass for one day and a dog died after being fed food with the yellow substance on it[39].

The report[40] of the Surgeon General's staff came to the conclusion that the yellow substance must be regarded as toxic, but that the potency of the substance may be of short duration.

A number of laboratories in various countries have analyzed samples from this incident, and small amounts of vomitoxin, diacetoxyscirpenol, nivalenol, T-2 toxin and fusarenon-X have been identified[41].

Conclusions

The events that are reported to take place at the time of alleged chemical warfare attacks cannot be explained on the basis of naturally occurring diseases. Neither mycotoxicoses nor other diseases occur in Thailand, and presumably in the immediately neighbouring countries, which are able to cause the rapid onset of symptoms or the effects on all forms of life (human, animal and plant life) that are said to occur.

It appears that a number of agents or a combination thereof have been employed, one being generally known as "Yellow Rain." Most of the features described with "Yellow Rain" are consistent with trichothecene mycotoxicosis, although the macrocyclic mycotoxins that cause such symptoms characteristically, have not been identified. On the other hand, it might be possible to induce severe symptoms with trichothecenes by the use of enhancing vehicles. It is also possible that the inhalation of the trichothecene mycotoxins has more serious effects that the usually studied oral uptake.

There is no doubt that *Fusarium* fungi, theoretically capable of producing trichothecenes, occur naturally in Southeast Asia, but this investigator did not find any toxins in the undisturbed environment,

nor did he find signs of occurrence of diseases caused by these toxins in this region.

Recently, a number of publications have appeared which describe occurrence of trichothecenes in food crops at elevated temperatures[42], which is not too surprising, but in general it can be said that the fungi capable of producing trichothecenes give better yields of toxin when cultured at low temperatures (0-5°C) than at higher temperatures (23-25°C)[43], although the ratio of the various types of toxin produced may vary[44].

Discussion

While most of the evidence so far seems to point towards the use of mycotoxins as one of the chemical warfare agents, there are still a number of questions and concerns. Firstly, there is still the unanswered question in which way the chemicals are delivered; it should be possible to find parts of the delivery system(s) or unexploded shells which would allow for identification of the toxin(s), but this would require unhindered access to the site of military action by neutral observers. Secondly, it is rather futile to debate whether mycotoxins are chemical warfare agents or not, when it appears that these agents are being used either only to instill fear and terror in unprotected troops and civilians with inadequate medical support[45], or on an experimental basis. As agents capable of causing terror, confusion and denial of territory due to killing animals and plants, they are unquivocally effective and induce, quite obviously, tremendous human suffering. This fact alone requires determined action by the world community, and it is not indicated to engage solely in scientific rhetoric before all the evidence is available, if evidence can be gathered at all. Hopefully, other nations will come forward with their findings.[46] The need for suitable verification methods at this time is evident and is best described by Mike Kergin's statement:

> It must be the goal to establish verification methods so that if chemical weapons are used, the UN or some other international agency, can quickly assemble an appropriate team of experts, take samples, and confirm or deny the use of such weapons.[47]

Analysis of samples that are handed over by refugees or victims are not very well suited to give definitive answers when there remains doubt as to the authenticity of the origin of the sample[48]. Stringent verification systems will be necessary to achieve a meaningful chemical arms prohibition. The problem of verification procedures has been reviewed by the International Federation of Chemical, Energy and General Worker's Unions and their report[49] summarizes this best by stating:

> First, there must be agreement on the specific chemicals to be prohibited. This means that agreed methods must be found to identify the chemicals most likely to be used for weapons purposes. Second, and most important, a way must be found to

check that states having joined the treaty really do destroy their weapons and refrain from making new ones.[50]

The report also suggests a number of possible ways to approach and achieve such objectives.

Any verification procedure will have to be based on the four principles of equity, non-discrimination, reciprocity and the preservation of national sovereignty, and will require major efforts by all concerned to agree on such procedures. There is little doubt that we need such verification.

References

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2. UN, General Assembly, Report of the Group of Experts to Investigate Reports of the Alleged Use of Chemical Weapons, no. A/36/613.
3. Protocol for Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases and of Bacteriological Methods of Warfare, Geneva, June 17, 1925.
4. Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, 1972.
5. op. cit., note 1, U.S. Dept. of State.
6. Trichothecenes are members of large group of naturally occurring toxins known as mycotoxins. The word, mycotoxin, is derived from the Greek "mykes" meaning fungus, and the Latin "toxicum" meaning poison. Trichothecenes, which are frequently produced by *Fusarium* spp. of fungi, have been associated with diseases in humans and animals. In 1943, Russian scientists determined that a disease known in Russia since the end of the 19th century under the name "septic angina," was caused by the ingestion of mouldy cereals and the name "Alimentary Toxic Aleukia" (ATA) was used henceforth. It is now known that T-2 toxin, one of the trichothecenes, play a major role in ATA. Other members of the trichothecene family, known as macrocyclic trichothecenes, are recognized as the causative principal of Stachybotryotoxicosis. This disease, principally a mycotoxicosis of horses and other livestock, was also first recognized in Russia in the late 1800's. Human Stachybotryotoxicosis can occur by handling (skin contact and/or inhalation) of contaminated fodder.
   A very comprehensive review of the topic of mycotoxins and mycotoxicoses can be found in: "*Mycotoxic Fungi, Mycotoxins, Mycotoxicoses. An Encyclopedic Handbook*," 3 Vols., ed. by T.D. Wyllie and L.G. Morehouse (New York and Basel: Marcel Dekker, 1978). For a recent review of trichothecene mycotoxins, see: Y. Ueno, "Mycology, Chemistry and Toxicology," Chapter 10, pp. 301-353, in, *Adv. Nutr. Res.*, Vol. 3, ed. by H.H. Draper (New York: Plenum Publ., 1980).
7. C.J. Mirocha et al, "Occurrence of trichothecenes in samples from Southeast Asia associated with 'yellow rain'," *Proc. V Intern. IUPAC Symposium on Mycotoxins and Phycotoxins* (Vienna, Austria, Sept., 1982), pp. 130-133.
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12. G.R. Humphreys and J. Dow, "An Epidemiological Investigation of Alleged CW/BW Incidents in SE Asia," Directorate of Preventive Medicine, Surgeon-General Branch, National Defence Headquarters, Ottawa, August, 1982; and,
Department of External Affairs, Report on Possible Use of Chemical Warfare Agents in Southeast Asia, "Refugee Interviews at Ban Vinai, May 5, 1982," Submitted to the UN on Sept. 7, 1982.
13. *The Nation* (Bangkok), Feb. 17, 1982.
14. *The Nation* (Bangkok), Feb. 19, 1982.
15. *Bangkok Post*, Feb. 21, 24, 1982 and *The Nation* (Bangkok), Feb. 21, 22, 1982.
G.R. Humphreys and J. Dow, "An Epidemiological Investigation of Alleged CW/BW Incidents in SE Asia," Directorate of Preventive Medicine, Surgeon-General Branch, National Defence Headquarters, Ottawa, August, 1982.
16. See fn. 12, Humphreys.
17. Anthrax, a bacterial disease, occurs in rural areas of Thailand with frightening frequency, but the epidemiology is characteristic of a cascade-like event. From one bovine death due to anthrax, for instance, the disease spreads in a fan-like pattern to people or other animals, but never do all species become affected at the same time. Plants are not affected at all.
Botulism, due to the toxin of the bacterium, *Cl. botulinum*, occurs occasionally. A typical case history involves either one family only or scavenger animals eating a carcass. Never is the whole population affected at once.
Rabies is quite common, but has a different symptomology.
In cattle, plant poisonings occur in selected areas. The same holds for the typical subtropical diseases that are encountered in this region.
18. A very concise and easy to understand description of chemical warfare agents can be found in: C. Levinson, *The Chemical Worker's Report on Chemical Warfare* (Geneva: International Federation of Chemical Energy and General Worker's Unions, 1982).
19. See fn. 1, U.S. Department of State, and fn. 12, Humphreys.
20. See fn. 5.
21. See fn. 6.
22. DMSO = Dimethylsulfoxyde, a drug used for treatment of arthritis and as a vehicle. See also: "Dimethylsulfoxyd DMSO, *Internat. Symposium* (Nov. 8-19, 1966, Vienna). G. Laudahn and K. Gertich, eds., Saladruck, (Berlin: 1966), also: Parker, W.A. and G.R. Bailie, "Current therapeutic status of DMSO," *Can. Pharm. J.*, 115 (1982), 247-251.
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31. T. Glinsukon et al., *J. Nutr. Assoc.* (Thailand) 14(1) (1980), 27-40 and many other publications from Mahidol University and other Thai scientists.
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34. T. Glinsukon, "Mycotoxins as a veterinary problem," *Kasetsart Veterinarians*, 2 (Oct. 1981), 211-223.
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37. See fn. 14
38. See fn. 12, Humphreys.
39. ibid.
40. ibid.
41. Personal communications received by the author.
42. S. Ghosal, et al., *Experientia*, 33 (1977), 574-575;
S. Ghosal, et al., *J. Pharm. Sci.*, 67 (1978), 1768-1769;
C. Rukmini, et al., *Food Cosmet. Toxicol.*, 18 (1980), 267-269.
43. G.R.F. Davis and J.D. Smith, *J. Invert, Path.*, 30 (1977), 325-329; and, *Arch. Intern. Phys, Biochem.*, 89 (1981), 81-84.
44. *Fusarium trincinctum*, for instance, was found to produce DAS and T02 toxin at 8°C and HT-2 toxin at 25°C. Bamburg et al., *Tetrahydron*, 24 (1968), 3329-3336.
45. See fn. 12, Humphreys.
46. According to hearsay in Bangkok in February, 1982, other nations were also actively gathering information in SE Asia.
47. M. Kergin (Member of the Canadian Mission to the UN), *Chem. and Engin.*, (July 5, 1982), 16.
48. When presented with a sample, there is no way of knowing whether this was not a deliberate "plant" by some party interested in this conflict. This is one of the major criticisms that have been levelled against the U.S. claims that mycotoxins were used as CW/BW agents in SE Asia.
49. See fn. 18.
50. op. cit., fn. 18, p. 12.