CONFERENCE SUMMARY

YELLOW RAIN: FINDINGS AND ASSESSMENTS

April 15 and 16, 1983

Introduction by the Conveners*

Beginning in 1976, reports of the use of chemical weapons in Laos came from highlander refugees entering Thailand. In December, 1980, the UN General Assembly asked for an impartial investigation into these reports, and into other allegations of the use of chemical weapons. In the fall of 1981, in a statement by Secretary of State Haig, the U.S. Government formally charged the Soviet Union with using or aiding in the use of chemical and toxin weapons in Indochina and Afghanistan. These charges were restated and amplified in reports by Secretary Haig in March 1982 and by Secretary Schultz in November 1982.

The publicly revealed evidence is based on testimony of refugees, medical examinations and tests of biomedical samples drawn from victims of alleged chemical attacks, and analyses of samples from the environment.

Biotoxins called trichothecenes have been detected in spots of 'yellow rain' on leaves and rocks, in pond water and in blood, urine and tissue from alleged victims. These toxins are produced by certain fungi which proliferate on grain and other plant materials. These toxin-producing fungi have been thought to be common in northern temperate zones, but much less so in the tropics.

Many take the charges of toxin warfare as proven. Some argue that the actions demonstrate not only that no reliance can be placed in international agreements for chemical or biological disarmament, but also that no reliance is possible in the field of nuclear arms control, unless hitherto unattainable standards of verification are met.

Others consider the allegations as unproven or implausible. Among their reasons are: the failure to find spent chemical munitions after reported chemical attacks, some of which are in accessible areas; the finding of dense, heterogeneous pollen assemblages in dried yellow-rain spots, difficult to explain as included in chemical munitions; the insufficiency of controls regarding possible natural occurance of the toxins; and the notion that whatever military efficacy the alleged uses of chemical or toxin weapons might possess would be outweighed by the risk of opprobrium following violations of international conventions outlawing such weapons.

The Soviet Union and its allies have opposed a United Nations investigation of the allegations. The UN observers were not permitted entry by the Governments of Afghanistan, Kampuchea or Laos. So far, the United States government has spent little effort on systematic studies -- essential for resolving important uncertainties -- of alleged human victims and controls, and of the natural environment in and near the affected regions.

The tangle of controversy over the reported use of chemical and biological warfare agents implies serious challenges for scientific inquiry. Where scientific evidence is incomplete and difficult to gather, fragments of such evidence are cited in urgent disputes, with large implications, that appear to demand prompt political action. The potential for misunderstanding of research results is large. Hence, the need to define areas of uncertainty and explore methods of reducing them is acute.

As a contribution to the process of clarification, 35 persons** from many disciplines involved in the analysis of evidence of chemical warfare assembled in Cambridge, Massachusetts, at the American Academy of Arts and Sciences on 15 and 16 April 1983. The conference 'Yellow Rain: Findings and Assessments', was sponsored by the American Academy, The Program in Science, Technology and Society of M.I.T. and the Institute for Foreign Policy and Analysis of Tufts University. The discussion focused chiefly on Indochina, although evidence from other areas was taken into account. No concensus was reached as to the artificial or natural origin of the yellow rain phenomenon. Some remained convinced that 'yellow rain' was the result of chemical warfare; some remained unconvinced. Participants heard evidence supporting a range of hypotheses and outlined avenues of further inquiry. What follows is a summary of points raised at the conference.

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* Carl Kaysen, Matthew Meselson and Stuart Schwartzstein

** (names and affiliations by working group) Analysis for Trichothecene Mycotoxins: Bruce Jarvis, Michael Marletta, Joseph Rosen, William Roush and Emery Sarver; Botany, Palynology and Mycology: Peter Ashton, James Bamburg, Gordon Congdon, David Jarzen, Matthew Meselson, Paul Nelson, Joan Nowicke, Donald Pfister, Samaniya Sukroongreung; Epidemiology, Pathology and Toxicology: John Constable, Timothy Dunnigan, G.R. Humphreys, David Luce, Herbert Marcovich, Margorie Meucke, Roger Rumpf, Bruno Schiefer, Diane Silimperi, Amos Townsend, Bernard Wagner and Gerald Wogan; Chemical Warfare: Gary Crocker, Esmet Ezz, Frode Fonnum; Carl Kaysen, James Leonard, William Miller, Julian Robinson, Emery Sarver and Stuart Schwartzstein.

A. Analysis for Trichothecene Mycotoxins*

1. Trichothecenes have been found in environmental and biomedical samples from alleged attack sites and human victims.

2. The available analyses of control samples are insufficient to rule out the possibility that the trichothecenes associated with alleged attacks are of natural origin.

3. Additional controls need to be analyzed, including

   a) environmental samples, such as yellow spots, from areas not subject to chemical attack.

   b) blood and urine from villagers and soldiers not involved in chemical attacks.

4. Suspected samples and control samples should be reasonably matched with respect to variables of possible importance, including conditions of collection and shipment, season of collection and, in the case of biomedical samples, diet and symptoms of illness.

5. Control samples and, where possible, samples from suspected attacks should be obtained in quantity sufficient to allow analysis in more than one laboratory. Analyses should be made not only for trichothecenes but also for man-made chemicals such as dispersing agents, anti-foaming agents and other synthetic substances.

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* Bruce Jarvis, Rapporteur

B. Botany, Palynology, and Mycology*

1. Spots of 'yellow rain' contain a high concentration of pollen grains.

2. The pollen, on taxonomic criteria, seems to contain more insect-borne forms than would be expected in airborne pollen.

3. Each spot contains pollen from a heterogeneous group of plant species.

4. Spots from different sites contain substantially different kinds of pollen grains.

5. Pollen-containing spots have been found in the conflict areas and in Bangkok, which is well outside of such areas.

6. Pollen in yellow spots reported to be yellow rain and in yellow spots collected in ecologically similar areas remote from military activity should be accurately identified by comparison with reference collections of pollen from the region.

7. The seasonality of flowering and insect activity in areas where yellow rain occurs should be considered. Environmental samples reported to contain toxin have been collected especially from late February through early April, a clustering toward the end of the dry season. In seasonal tropical areas insect abundance and behavior can be very seasonal in response to the availability of pollen and nectar.

8. Samples from the natural environment, including yellow spots, soil and foodstuffs likely to be substrates for fungal growth, both within and outside the conflict areas, should be analyzed for the presence of fusarium species and other fungi able to produce trichothecenes. Cultures of such fungi grown on these substrates should be tested for trichothecenes. Samples should be taken at various times of the year, including the end of the dry season.

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* Gordon Congdon, Rapporteur

C. Epidemiology, Pathology, and Toxicology*

1. Trichothecene mycotoxins have been found in refugee blood, urine and tissue samples in Southeast Asia. The origin of these mycotoxins and their relationship to disease in refugees is unclear.

2. At present, several problems prevent clear definition of a trichothecene disease phenomenon in Southeast Asian refugees. The most frequently reported symptoms include nausea, vomiting, diarrhea, dizziness, skin blistering, rashes, ataxia, loss of muscular control, chest pain, shortness of breath, cough, and anorexia. These symptoms can also be caused by one or more of the diseases endemic to Southeast Asia. Therefore, it is difficult, by medical history alone, to exclude combinations of these diseases as the cause of the reported symptoms.

3. There are serious gaps in our knowledge of the effects of trichothecene mycotoxins on humans. Too little is known about the relations between the intensity and type of exposure (oral, inhalation, percutaneous) and the severity and type of the symptoms produced.

4. Another confounding factor is stress affecting the refugees before and after they reach camps in Thailand. The environmental stresses to which they are exposed are likely to increase their susceptibility to toxic agents, such as mycotoxins, but also to other possible etiologic factors. The refugees live outside their traditional cultural environment, often without their family support groups. Their diets are frequently inadequate and nutritional deficiencies are common. Also present are parasitic, fungal, bacterial and viral infections, combinations of which affect a high proportion of the refugees. All of these factors can predispose one to illness that might otherwise have not occurred.

5. We are not aware of any documentation of naturally occuring outbreaks of trichothecene mycotoxicoses, either in animals or man, in Southeast Asia. There have been several published reports,however, of trichothecenes in crops in tropical areas of India. Factors involved in the selection and storage of foodstuffs may allow bacterial or fungal contamination and ingestion of toxic metabolites. In other parts of the world where trichothecene mycotoxins are known to occur, however, outbreaks of mycotoxicoses have been described in both human and animal

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* David Luce, Rapporteur

populations. The lack of such reports from Southeast Asia mitigates against the natural occurrence of trichothecene mycotoxicoses, but, in view of the lack of base-line data, does not rule it out.

6. The situation could be greatly clarified by epidemiological study by a qualified medical and anthropological surveillance team. Systematic examination should include oral history, medical examination, and trichothecene analysis. Interviews should be designed to determine whether reports have an internal consistency and plausibility as to time, place and circumstances of exposure. There should be a concurrent examination of controls, matched so far as practicable with respect to general living conditions, natural environment and diet.

D. Chemical Warfare*

1) Resort to chemical warfare during conflicts of the type under consideration might be favored by three factors; (a) operational circumstances serving to enhance the cost-effectiveness of CW in comparison with other weapons; (b) war aims that could be served by the peculiarly intense morale effects of CW; and (c) logistical circumstances serving to increase the relative availability of CW weapons. Given the 'low intensity' of the fighting and the general absence of antichemical protective equipment, at least the first of these factors might well be operating.

2) Chemical irritants or other incapacitating agents could perhaps satisfy military requirements set by factors (a) or (b). Deaths have sometimes followed use of standard agents of these types, but it seemed inconceivable that the great numbers of people reportedly dead in Afghanistan and Southeast Asia from CW attack could be explained in this way. Traces characteristic of such agents had not been found in the available sample materials.

3) From the experiences of people who had worked with trichothecenes such as T-2, it appeared that the intense local effects of these substances on human skin and eyes could be at least comparable with those from standard military harassing agents or police tear gases.

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* J.P. Perry Robinson, Rapporteur