

To the Editors:

Chester Mirocha clearly does not understand the results and implications of our study of yellow rain. We have sought to determine the nature of the alleged chemical-warfare agent consistently described by the U.S. Government as yellow and rainlike. The report of Secretary of State Alexander M. Haig in March, 1982, stated that "the majority of the attacks were carried out by aircraft spraying a yellowish substance which 'fell like rain.'" Later that year, the report of Secretary George P. Shultz affirmed that "descriptions of the 1982 attacks have not changed significantly from descriptions of earlier attacks. Usually the Hmong state that aircraft or helicopters spray a yellow rain-like material on their villages and crops." And most recently, in 1985, an article coauthored by a Central Intelligence Agency official with primary responsibility for yellow-rain studies reiterated that "aerial attacks, usually by spray, dispersed yellow to yellow-brown liquid or semi-solid particles that fell and sometimes sounded like rain when striking thatched rooftops" (C. J. Stahl, C. C. Green and J. B. Farnum, 1985).

The Government's description of the alleged agent is well supported by the evidence. Nearly all interviews with the Hmong regarding the residue of the presumed agent describe it as yellow, and nearly all samples of it are also yellow. Contrary to Mirocha's impression, our working definition is that yellow rain is a yellowish material alleged to have been deposited in chemical attacks in Southeast Asia. Moreover, the samples we have studied include the yellow scrapings analyzed by Mirocha and Rosen and defined by them as yellow rain.

To the best of our knowledge all samples of the yellow material examined under the microscope, whether spots or scrapings, are without exception found to be composed mainly of pollen. They include samples from more than 30 alleged attacks, collected from 1979 on. They specifically include the yellow scrapings reported by Mirocha and Rosen to contain trichothecene mycotoxins. A leaf sample and a sample of pond water are also reported by Mirocha to contain the toxins. But leaves and water cannot be the chemical-warfare agent itself, since no one asserts that the alleged attack aircraft release such materials. Thus, if one accepts the well-supported and unchanging assessment of the U.S. Government that the alleged chemical-warfare agent leaves yellow residues, one must explain why its principal ingredient is pollen. Our explanation, based on evidence pub-

lished in *Nature* and in SCIENTIFIC AMERICAN, is that the material is bee feces. We believe this conclusion is generally accepted by knowledgeable Government experts in the U.S. and in allied countries.

This poses a critical problem for the trichothecene-warfare hypothesis. If the yellow material is bee feces and therefore is not released from aircraft, then the purported trichothecenes would have to be dispersed in some other physical form. What could it be? Certainly not a gas: trichothecenes have negligible vapor pressure. Not an aerosol either: aerosols do not fall and the alleged witnesses do not describe the very dense ground-level clouds that would be required. What witnesses (including witnesses to several of the alleged attacks from which Mirocha's samples come) are in fact reported to say is that the agent is sprayed by aircraft and leaves a yellow residue. But no known samples of such deposits, including those reported by Mirocha and Rosen to contain trichothecenes, have been shown to be anything other than bee feces.

Therefore in order to rescue the trichothecene-warfare hypothesis one must reject the U.S. Government's description of the alleged agent as yellow and rainlike. It is then necessary to postulate a different material, one that actually is released from aircraft, contains toxins and frequently falls on villagers in lethal quantities but that, strangely enough, has gone unnoticed. No one has come up with a plausible hypothesis for what such an elusive material could be. Unless an explanation can be devised, and supported with solid evidence, the trichothecene-warfare hypothesis collapses.

What explanation is then left for the reports of trichothecenes? Occasional or sporadic natural occurrence is not ruled out. Mirocha does not mention the finding of Greenhalgh and his colleagues (1985) that one out of four *Fusarium* isolates from a leaf collected in Thailand produced 1,000 parts per million (dry weight) of trichothecenes when grown on glucose-yeast medium. But the U.S. Army's Chemical Research and Development Center has found no trace of the toxins in any of the more than 80 samples from alleged attacks that it has analyzed. These consistently negative findings, and similar results from other laboratories, provide strong evidence against common natural occurrence of the toxins in such materials and also against their use as chemical-warfare agents.

Mirocha characterizes his evidence for trichothecenes as "unequivocal." Based on our own laboratory experience with mass-spectrometric analysis

of trace components in natural materials, we would reserve this adjective for cases in which three principles of forensic chemistry are met. First, results for critical samples must be unambiguously confirmed by independent analysis. Second, adequate control samples must be analyzed concurrently, and the results must be fully disclosed. Third, the integrity of the samples must be assured. None of these conditions was met in the present case.

Mirocha asserts without evidence that the Hmong would generally recognize bee feces for what they are. If he were right, the Hmong would have practiced massive deception since handing in the first of many bee feces samples to U.S. officials in 1979. Actually, it appears that Asian villagers often cannot identify bee feces. None of the Hmong we interviewed did so, nor did most of the Thai villagers we also interviewed. It is not surprising that villagers misinterpret the fecal showers of honeybees flying too high to be seen or heard. In 1976 yellow showers in Jiangsu, China, mystified rural communities and were erroneously suspected of being toxic until university scientists identified them as bee feces (Zhang Zhong-ying et al., 1977, and personal communication). Two other cases on record could be similar misperceptions of bee feces. Last year yellow showers were attributed by Thai villagers to imagined Burmese atom bomb tests. And, in 1964 at the United Nations Security Council, the government of Prince Norodom Sihanouk charged that U.S. and Vietnamese aircraft were spraying Cambodian villages with lethal yellow powders.

Maintaining a critical approach to scientific data can be difficult when an issue becomes politically charged. In 1982 Mirocha began an article reviewing his yellow-rain research with this assertion: "During the last 6 to 7 years, chemical and/or biological warfare has been waged in Laos, Kampuchea and Afghanistan resulting in the death of 75-100,000 human beings." Considering that there is not a single unambiguous case on record of a medically authenticated victim, living or dead, nor is there either a single chemical canister or a chemical munition, what hard data justify his assertion?

In short, the evidence for mycotoxin warfare fails the test of critical examination.

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