

THE SEARCH FOR YELLOW RAIN

Matthew S. Meselson is one of those rare individuals who have distinguished themselves in both science and arms control. Trained in physical chemistry at the California Institute of Technology, Meselson joined Harvard University where he teaches biochemistry and molecular biology. He has made several pioneering discoveries in molecular genetics, his first being a seminal demonstration of DNA replication. A member of the National Academy of Sciences, the Royal Society, and numerous other scientific organizations, Meselson is presently doing research in molecular genetics.

Meselson is known in arms control circles for his contributions to the arms control of chemical and biological weapons. As a consultant to the Arms Control and Disarmament Agency (ACDA) during the 1960s, Meselson was a key influence in Nixon's 1969 decision to renounce biological warfare and destroy the U.S. stockpile of germ weapons. The 1970 decision to phase out the use of herbicides in the Vietnam war has also been attributed to a report co-authored by Meselson.

In 1982, Meselson began an investigation of "yellow rain." Since the late 1970s, Laotian refugees have reported being attacked with a poisonous, yellow, rain-like agent. Although these refugees provided many samples of the yellow material, the U.S. government could not detect any known chemical agent. But in 1981, the Reagan administration announced that trichothecene mycotoxins, a chemical poison produced by fungi, had been found in the yellow spots. The administration charged that the use of mycotoxins by the Soviet-supported Vietnamese and Laotian governments flagrantly violated the 1925 Geneva



Protocol and the 1972 Biological Weapons Convention.

Meselson, with the help of other scientists, discovered a surprising and radically different source of the yellow spots: swarms of honeybees dropping excrement in cleansing flights. Though the administration has not yet retracted its yellow rain charge, what was once the "smoking gun" in its case has now fallen into considerable doubt. Given the importance of the yellow rain debate to the chemical and biological arms control regime, *Arms Control Today* believes Meselson's recent work to be of particular interest. This interview was conducted by Peter Liberman on July 25. *ACT*

Arms Control Today: You started working for ACDA in 1963. Is this when you first became aware of the dangers of chemical and biological weapons (CBW)?

Meselson: I was first assigned to work on European theater nuclear problems, but it seemed unlikely that I could contribute anything useful in the nuclear field, which was already receiving a good deal of thoughtful attention. In contrast, ACDA had nobody working on the problems of CBW. I am a chemist and a biologist. I asked Franklin Long, then Director of the Bureau of Science and Technology, to reassign me to CBW, which he did.

After a few days, I decided to leave chemicals aside, because biologicals looked much more dangerous for the United States. I went to Fort Detrick to learn what we were doing and to the CIA to see what we thought others were doing. And I read the classified and open literature.

It was clear that the principal attribute of biological weapons is their potential for threatening or carrying out the destruction of populations over large areas. A small quantity of certain bacteria or viruses could be enough, if dispersed as an aerosol, to cause inhalatory infection over many square kilometers. And no reliable defense, such as immunization or therapy, was or is foreseeable.

Therefore, the proliferation of biological weapons to other nations, in particular to non-nuclear nations, or to dissident groups, could be extremely dangerous. It could open up a major new dimension of strategic threat and international instability.

Once developed, the technology of biological weapons could proliferate rather easily. It is best that I refrain from describing specific potential threats. But, speaking generally, you might say that biological weapons could become the poor man's hydrogen bomb. So if you want to prevent biological proliferation, you should try particularly hard to forestall the inclination to acquire such weapons.

ACT: But what about the argument that the U.S. needs biological weapons to deter others from using them?

Meselson: This is a false argument. The United States already has and will continue to have weapons that can threaten assured destruction over large areas—thermonuclear weapons—as well as large conventional forces. For us, therefore, having biological weapons would provide no important addition to deterrence.

On the contrary, if the United States is perceived to have an offensive biological weapons program, as we did have in the '60s, it will encourage those without such programs to question their policies and will provide arguments and incentives for them to follow suit. This logic dictated that we should categorically and convincingly renounce biological weapons, while, however, keeping watch on what others are doing. I didn't find anyone at high levels who disagreed with this analysis.

But the difficulty at the time was that other more pressing matters made it difficult to get attention for BW policy. The U.S. program was guided mainly by low-level considerations of what could be done technically and not by any adequate national policy. Six years later, in 1969, President Nixon requested a National Security Council review of the entire subject, much of which is now declassified. After the review (actually two reviews, the second devoted just to toxins) the President decided that it was in our interest to renounce the development, production, and possession of biological and toxin weapons, which we did. This is still the U.S. policy. Existing weapons and stocks were destroyed, and facilities at Fort Detrick, Maryland, and Pine Bluff, Arkansas, were opened up and redirected to peaceful research.

ACT: Many, including Princeton physicist Freeman Dyson, have attributed Nixon's decision to your efforts and the papers that you wrote and circulated. Could you expand a bit more on your contribution?

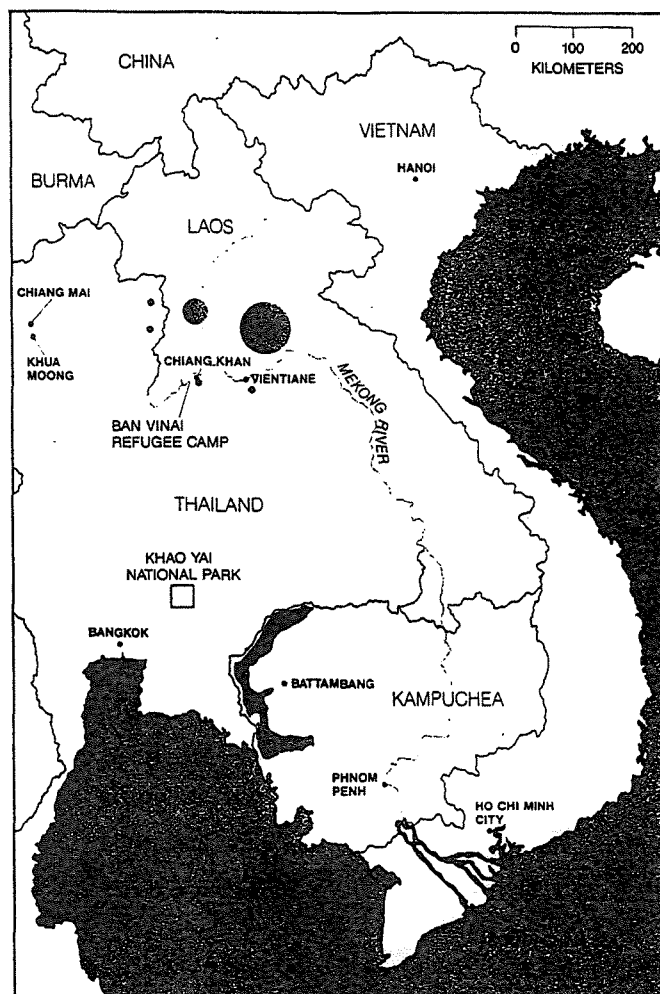
Meselson: I don't know what effect I had. There were senior officers of the government who gave careful attention to the subject, especially Secretary of Defense Melvin Laird and National Security Advisor Kissinger. The State Department and the military played leading roles in the inter-agency working group.

The President's Science Advisory Committee made a valuable contribution and the NSC staff who managed the review were very thorough. All of the relevant agencies of the government supported the President's decision.

The U.S. decision to renounce biological and toxin weapons was not linked to any treaty or negotiations. The treaty approach was considered at the time, but once it was decided that having an offensive BW program was actually contrary to our own security interests, it was agreed that decisive action, without the delay and complications of negotiations, was the proper course. It was agreed, however, that a treaty could enhance the benefits of our own unilateral renunciation.

President Nixon decided to seek U.S. ratification of the 1925 Geneva Protocol and to support the British initiative at Geneva which led to the Biological and Toxins Weapons Convention. The protocol is, in effect, a no-first-use agreement for chemical and biological weapons, while the convention goes further, by prohibiting the development, production, possession, and transfer of biological and toxin weapons. Both treaties were ratified in 1975, by President Ford.

Failure to understand the history and the logic of the U.S. renunciation of biological and toxin weapons can lead to a serious error. It's sometimes said that if new developments in molecular



Regions of alleged yellow rain attacks are shown on the map in color. Most of the allegations have come from Hmong refugees in the Ban Vinai refugee camp in Thailand. The author found honeybee feces samples resembling "yellow rain" in the Khao Yai National Park, and was caught in a fecal shower in the village of Khua Moong. (*Scientific American*, September 1985)

biology make biological weapons more effective and easier to produce, they might become more attractive to the U.S. Exactly the opposite is true. Leaving aside the fact that the so-called new developments are mainly uninformed speculation and not reality, making biological weapons even more effective and even easier to produce would make even more compelling the arguments for the existing U.S. policy of non-proliferation, of which the credibility of our own categorical renunciation is the most essential component.

Those who do not understand this play a dangerous game, which could cause great harm to the United States. There is a new defense industry trade journal called *Nuclear, Biological, and Chemical Defense and Technology International*, and in the first issue there is a photo of President Nixon with the caption "Implemented by Nixon, Biological Arms Convention was a flop."

ACT: *Was that because of yellow rain?*

Meselson: That is the implication of the article, which is, charitably speaking, loaded with misinformation. First of all, what Nixon implemented was the U.S. unilateral renunciation of biological and toxin weapons. The convention was a separate thing and came later. As for the convention, there is not a single substantiated violation. The yellow rain of course was alleged to be a violation. But the U.S. government's case for yellow rain being toxin warfare has collapsed.

ACT: *That brings us to your investigation into yellow rain. Along with a few botanists and entomologists you have persuaded most of the scientific community that the Reagan administration's smoking gun on the BW treaty is really a trumped up charge.*

Meselson: I wouldn't call it trumped up. I would call it a case of intelligence failure and of premature judgment at high levels. The failure resulted from a corruption of the intelligence process, in which political factors favored hasty conclusions and discouraged hard-headed critical analysis and independent review. With the "smoking gun" speech by Secretary of State Alexander Haig in Berlin in September 1981, the administration committed itself with great publicity and at the highest levels without adequate scientific input. Once this was done, they had entered a scientific blind alley.

"The proliferation of biological weapons to other nations, in particular to non-nuclear nations, or to dissident groups, could be extremely dangerous. It could open up a major new dimension of strategic threat and international instability."

ACT: *Could you describe what some of the crucial discoveries and turning points were in the investigation?*

Meselson: A very important turning point was the tardy recognition, in 1982, that the main component of yellow rain is pollen. The very first samples of the alleged chemical warfare agent turned in to U.S. officials by Hmong refugees from Laos, in June and in October 1979, were yellow spots on pieces of vegetation. The vast majority and perhaps all of the samples claimed by the Hmong to be released from weapons and collected at sites of attack are yellow spots or yellow scrapings. From the first report of Secretary Haig to the Congress, in March 1982, to a recent publication co-authored by a CIA officer responsible for yellow rain matters, U.S. officials continuously stated that the alleged agent is usually sprayed by aircraft and is yellow and rain-like. Yet, in spite of the fact that we had many samples of

"You might say that biological weapons could become the poor man's hydrogen bomb."

the yellow material, it was not discovered until early 1982 that it is mainly pollen, and then not by the United States. It was the British, Canadians and Thais who discovered it, all at about the same time, simply by looking at it under the microscope. To the best of my knowledge, all of the many samples of yellow material from alleged attacks have been found to consist mainly of pollen when examined under the microscope.

I learned about the pollen late in 1982, from two remarkable on-the-record State Department and U.S. Information Agency press briefings, held November 29 and 30. It was stated that the pollen was not wind-borne but collected by insects, "... the type of thing ... a honeybee would take from flowers." This description by a State Department intelligence officer is the earliest public claim that I know of which implicates bees in yellow rain. But the possibility of a natural origin was not mentioned. Instead, a Defense Intelligence Agency scientist who was on the briefing team stated as "our current theory" that the pollen was added deliberately as a carrier of toxic chemicals, to be wafted into the wind as an aerosol for people to breathe after the drops of yellow rain dry out.

The U.S. failure after more than two years of study to discover that the yellow rain samples were mainly pollen; the failure even to mention the possibility of a natural explanation; the physical impossibility of getting an aerosol from a congealed spot of yellow rain by wind; and the willingness to put such nonsense directly into the public record made me conclude that the government investigation of yellow rain was a mess. I decided that I had better get some samples to look at in my own laboratory, which I did. But aside from confirming that the spots were mostly pollen, about a million pollen grains per spot, I couldn't figure out the origin of the material. So I went to Dr. Joan Nowicke, the resident pollen expert at the Smithsonian Institution in Washington. She had already looked at some yellow rain samples for the Army and agreed to examine the samples I brought her. This was the beginning of months of painstaking work by Nowicke, identifying the different kinds of pollen in yellow rain samples.

The specific hypothesis that yellow rain is bee feces came from a bee expert at Yale, Professor Thomas Seeley. This came about as a result of a conference on yellow rain in April 1983, which Carl Kaysen, Stuart Schwartzstein and I organized at the American Academy of Arts and Sciences in Cambridge. There were 34 participants, specialists from the U.S. government and other governments and from academic institutions. Various aspects

For additional copies write to:
Council for a Livable World Education Fund
20 Park Plaza
Boston, Massachusetts 02116



A scanning electron micrograph of an alleged yellow rain sample supplied to Dr. Joan Nowicke by ABC Television News. Researchers found that this sample, and other yellow rain samples, consisted largely of pollen grains remarkably similar to those found in the feces of the giant Asian honeybee. The magnification is 700 diameters.

of the yellow rain problem were discussed, including the nature of the yellow material. Nowicke had some preliminary pollen identifications by then and so did investigators in Australia and Canada. Professor Peter Ashton, a Harvard tropical botanist, stressed that these particular pollens come from plant families common in Southeast Asia that are frequently visited by wild bees. But we still didn't hit on the idea of bee feces, perhaps because we didn't realize that pollen grains would still be recognizable after passage through the digestive system. But right after the conference, Ashton telephoned Seeley, who said that the description of the spots sounded like honeybee feces.

Then we got to work. We had samples of yellow rain, in the form of yellow spots on vegetation and yellow scrapings, turned in by Hmong in 1981 and 1982 from alleged attacks in Laos. Later, we obtained other samples, including one given to U.S. government investigators by Hmong refugees in 1979. We measured the sizes and weights of the spots, the number of pollen grains per spot and per milligram of material, and the presence or absence of protein inside the pollen grains (which is digested away in the gut of the bee). In these and every other respect we tested, the yellow rain samples matched feces we obtained from Asian species of honeybees.

Dr. Nowicke determined the particular kinds of pollen and found that they match the kinds that honeybees in Southeast Asia gather. Pollen identification can give a very specific fingerprint. There are about a hundred thousand species of flowering plants in Southeast Asia—about three hundred thousand in the world. But the yellow rain samples contained only a few of these types and these are the very types collected by *Apis dorsata*, the giant Asian honeybee.

ACT: At some point didn't you actually go to Southeast Asia?

Meselson: In March 1984, Seeley and I went to Thailand, where he had studied wild honeybees for several months in 1979-1980. Neither he nor our Thai collaborator and regional honeybee expert, Professor Pongthep Akkratanakul, had known of fecal showers from tropical bees. But during our field study we located nests of *Apis dorsata* and observed nearby showers of yellow drops like those described by the Hmong refugees. The drops were mainly pollen and clearly were honeybee feces. We were directly under a shower that lasted about five minutes and deposited about 200 spots per square meter. But the bees were flying too high to see or hear. We also by that time had learned of a 1977 Chinese publication reporting massive showers of what they called yellow rain, covering areas up to several acres. This and a subsequent publication stated that the Chinese villagers did not know what the yellow material was and that some of them thought it was poisonous. But Chinese scientists discovered it was mainly pollen and identified it as honeybee feces. And they found no evidence of toxic effects on the villagers.

In Thailand we questioned both Thais and Hmong, showing them spots of bee feces on leaves and asking them if they had ever seen such spots before. Nearly everyone said "no." Very few identified them correctly. Amongst 39 Hmong, there was only one man who said that it might be insect droppings, but then he changed his mind, and agreed with two men standing next to him who said it was chemical warfare. Two other groups of Hmong men also told us that it was chemical warfare.

"I would call it [yellow rain] a case of intelligence failure and of premature judgment at high levels. The failures resulted from a corruption of the intelligence process in which political factors favored hasty conclusions and discouraged hard-headed critical analysis and independent review."

ACT: If the yellow rain was from natural causes, bee droppings, then why did reports of yellow rain attacks stop in 1983-84?

Meselson: They didn't stop. There have been reports of yellow rain poisonings in Thailand and Cambodia in the press just this year. There appears to be some kind of hysteria which passes through the region from time to time. The earliest reports I know of toxic yellow material sprayed from planes were from Cambodia in 1965. That summer, the government of Prince Sihanouk formally charged in the U.N. Security Council that the U.S. was responsible. And then we have the Chinese reports of toxic yellow rain in 1976 in Northern Jiangsu, which were shown to be bee feces and harmless.

Keep in mind also that starting in mid-1983, the Hmong leadership and then the larger Hmong community learned of western scientific reports that yellow rain is actually bee feces. As the correct explanation became known, it is not surprising that the reports subsided.

ACT: *But what about the chemical evidence for toxins?*

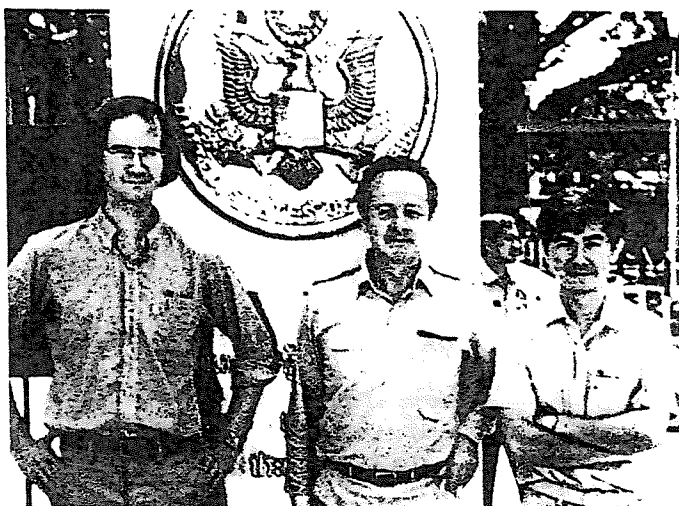
Meselson: The U.S. Army has analyzed more than 85 samples from alleged attacks in Southeast Asia and has never found T-2 or other trichothecene toxins, which are the toxic agents claimed by the State Department. More than 30 samples from alleged attacks have been analyzed by the British Chemical Defense Establishment, five were analyzed by the French Ministry of Defense and about a dozen by the Swedish National Defense Institute. All of these samples tested negative. The only laboratory which the State Department claims *has* found trichothecenes in samples from alleged attacks is that of Dr. Chester Mirocha at the University of Minnesota. In addition, Dr. Joseph Rosen of Rutgers reported a positive sample. Mirocha received five samples from alleged attacks, sent to him by the Defense Intelligence Agency and reported four of them positive. Rosen received his sample from ABC Television News. Neither laboratory presented adequate controls and the positive results were not confirmed in other laboratories.

The overwhelming chemical evidence is that samples alleged to be from attack sites in fact do not contain trichothecenes. The very limited evidence on which Secretary of State Haig went forward in 1981 has not held up. Mirocha also reported trichothecenes in blood and urine of alleged chemical warfare victims. But recently, the Canadian government has reported that there is T-2 in the blood of a small percentage of Thais selected as controls, suggesting occasional natural contamination of the local diet by this toxin, which is made by a mold.

"Not one of the yellow samples has been found to be anything other than honeybee feces. But bee feces do not come out of weapons."

The bee feces finding bears directly on the question of chemical warfare generally. The scenario for chemical warfare has to include an explanation of how the chemical warfare agent moves through the air to the target population. It can't move by spiritualism. It has to be a gas, or a very fine mist—that is, an aerosol—or a coarser spray. Some physical form. If the material is released from altitudes of more than a few dozen feet, it must be coarse. This is because gases and aerosols drift downwind instead of falling on an intended target.

So far, this is fine: the majority of the reports containing such information do indeed indicate a coarse spray. Residues of it are almost invariably described by the Hmong as yellow. Moreover, every sample I know turned in by Hmong and alleged to have been sprayed in an attack is yellow. But without exception,



*Yale Professor Thomas Seeley (left), Dr. Matthew Meselson (center), and Thai honeybee expert Professor Pongthep Akatanakul at the U.S. Embassy in Bangkok in 1984. In their field studies, the biologists interviewed Hmong refugees who had experienced yellow rain, and closely observed the honeybee, *Apis dorsata*.*

all of these samples are found to be mainly pollen when examined microscopically. This includes the yellow powder samples claimed by Mirocha and Rosen to contain toxins. Not one of the yellow samples has been found to be anything other than honeybee feces. But bee feces do not come out of weapons. Therefore, if one wants to believe the State Department's allegations of chemical warfare, one must postulate some inexplicably elusive kind of spray which has fallen in quantities so large as to have killed thousands of people, and yet has not been described and has not been sampled. That is a colossal missing link. And, because it is missing, the government's claims of lethal chemical warfare, whether with trichothecenes or with something else, are undermined.

A further implication of the bee feces findings is that there is a problem of credibility when an alleged witness claims that a chemical attack coincided with a yellow shower. Nests of wild honeybees are rare, and the chance that the bees would come out and defecate just over the same place and at the same time as a chemical attack is negligible. In fact, the reports were collected in a way that should have given them very little credibility in the first place.

ACT: *In what sense?*

Meselson: The interviews were conducted in such a manner that the alleged witnesses knew the subject was chemical warfare and presumably knew what the interviewers wanted to hear. This seriously compromises the reliability of the interviews. There were no truly independent cross-checks of individual reports using independent sources and independent interpreters. Beyond that, the existing reports have been misinterpreted in the direction of the chemical warfare hypothesis. For example, Professor Jeanne Guillemin, an anthropologist at Boston College, made a study of the interviews and found, among other things, that the set of symptoms claimed by the government to be a "perfect fit" to trichothecene toxin symptoms is very seldom found in the actual interview reports.

ACT: *Do the claims of the alleged witnesses give you any concern that would justify a further investigation?*

Meselson: They did at the time. I thought maybe some kind of chemical attacks *were* going on. Further investigation was certainly in order. But it has now been done and the result is that the evidence for the U.S. government's allegation of toxin warfare has collapsed. This is uniformly reflected in the scientific press, in *Nature*, *Science*, and *Chemical and Engineering News* and other scientific journals.

"It would be good if we could admit that the yellow rain [charge] was wrong. Around the world people would say, 'There is one of the few governments on the planet that can admit error.'"

ACT: *How could such an "intelligence failure" have occurred?*

Meselson: Part of the problem was that having only one hypothesis is an unscientific way to approach a problem. It cripples scientific investigation. Another problem was that there was no incentive after the speech of Secretary Haig in Berlin for disproving what the secretary had said. Who wants to go out and say, "Boss, we got it all wrong. And, we've made a fool out of you." Moreover, there's a strong current in intelligence work which makes it easy to report information politically acceptable and inhibits the flow of information, or even investigations, that one knows will be greeted with displeasure. This is true in every administration, but it's more severe today.

ACT: *Is the Biological Weapons Convention going to survive the yellow rain controversy and continue to be an effective arms control measure?*

Meselson: The United States is not going to renounce the BW Convention. But more realism is needed in these discussions. One should in the first instance judge a treaty by whether or not there have been substantiated violations. I would strongly assert that there are no such violations of the BW Convention.

Could you have a better treaty, one that would create more trust and better evidence of compliance? Clearly, yes. It is important to get the Soviets to talk to us more than they have. We should try to establish a regular private forum in which we talk with them about the BW Convention and BW non-proliferation. One thing that should be on the agenda is the anthrax outbreak in Sverdlovsk, Russia, in 1979. The U.S. is concerned that it may have been related to military activities. I took some part in the inter-agency review of this. Without compromising classified information, I can say that I think the case for a military origin of the outbreak is unconvincing. The case for a natural outbreak

is at least as plausible. But I am concerned and it is important to resolve the matter.

It would be good if we could admit that the yellow rain was wrong. In the long run, it would do our country good, in fact, because around the world people would say, "There is one of the few governments on the planet that can admit error." And ours can, because we're not talking here about a value, or a principle—we don't believe in the principle of yellow rain—we believe in the principles of freedom, of honesty, of self-determination—those are the things we believe in. And you demonstrate belief in these principles, and strengthen the principles by admitting error. It's in a totalitarian country that you can't admit error.

And that, I think, would advance the cause of biological arms control. It is in our interest to have more communication with the Soviets. Making erroneous accusations does not encourage communication. In this area, our interests are similar. Our major interest in this field is nonproliferation.

ACT: *What are the implications of the collapse of the administration's yellow rain case for arms control in general?*

Meselson: We are now debating the government's intention to exceed the SALT limits. One argument that has been often put before the public is that we should exceed the SALT limits because the Soviets have been violating treaties. That argument, I think, is greatly undermined by the collapse of the yellow rain allegations. Of the several instances of treaty violations which the President has cited to the Congress in his compliance messages, all but one of them I think can be fairly said—although they are annoying and difficult—are at the edges of the interpretation of

"One argument that has often been put before the public is that we should exceed the SALT limits because the Soviets have been violating treaties. That argument, I think, is greatly undermined by the collapse of the yellow rain allegations."

the treaty, and certainly don't provide evidence that the Soviets routinely, ruthlessly, violate treaties. The yellow rain, however, if it had turned out to be true, would clearly be a ruthless, continued violation of a quite recent treaty, as well as killing a lot of people. If that had been true, it would have been more than self-evident that the Soviets don't care at all about treaties.

With the collapse of the yellow rain charge, the claim that the Soviets deliberately and flagrantly violate arms control treaties collapses. There may or may not be good other arguments for exceeding the SALT limits. But the administration's handling of the yellow rain episode raises questions about its other non-compliance charges.