

Can an Attribution Assessment Be Made for Yellow Rain? Systematic Reanalysis in a Chemical-and-Biological-Weapons Use Investigation

by Rebecca Katz and Burton Singer

Politics and the Life Sciences | 24 August 2007 | VOL. 26, NO. 1

James J. Heckman



Econ 312, Spring 2022

- There is a science to the collection of evidence in an intelligence investigation. Experienced analysts collect information, analyze relationships, draw tentative conclusions.

Background

- The late 1970s was a tumultuous time for Southeast Asia and Afghanistan.
- In Laos, the United States had engaged the Hmong, an ethnic minority, to create a resistance army in the fight against communist Vietnamese and Pathet Lao forces.
- In 1975, after many years of war, the Pathet Lao took power in the country, the United States pulled out, and the majority of Hmong were left behind, although given their active role fighting the ruling body, many began to flee across the Mekong River into Thailand.

- With a Vietnamese-backed government in power, Khmer Rouge forces joined with other Cambodian parties opposed to the government to form a coalition of resistance fighters hidden primarily along the Thai border.
- Several thousand miles away, Afghanistan was experiencing regime challenges, and, in December 1979, the Soviet Union invaded Afghanistan.

- Starting in the late 1970s, there were reports of chemical- or toxin-weapons use against three peoples— the Hmong in Laos, the Khmer in Cambodia, and the Mujahadin in Afghanistan.
- Accounts often described events in which a helicopter or airplane had flown over a village and released a colored gas that would fall in a manner that looked, felt, and sounded like rain.
- Many colors of gas were reported, but the color most commonly reported was yellow, whence the name “Yellow Rain.”

- If true, these events would have been in direct violation of the Geneva Protocols and, if the agent employed was a toxin, the Biological and Toxin Weapons Convention.
- Additionally, any intentional use of chemical or toxin weapons against civilians would have been considered a human-rights violation and, in the context of conflict, a war crime.
- Hmong in Laos, Khmer Rouge resistance fighters in Cambodia, and Mujahadin resistance fighters in Afghanistan described similar types of attacks and subsequent symptoms, raising suspicions that the same agent and attack mechanism were being used in all three sites.

- *Common symptoms included nausea, vomiting, diarrhea, dizziness, difficulty breathing, eye irritation, and blistering or other skin rash. In the most severe cases, victims were said to have had bloody vomitus and bloody diarrhea, as well as subconjunctival (“under the lining of the eye”) and subungual (“under the nail”) bleeding.*

- The primary competing theory came from members of the academic community, led by Dr. Matthew Meselson of Harvard University.
- Meselson and his team, suspicious of the government's findings and not fully satisfied by the scientific rigor of its published analysis, hypothesized that the events reported by the Hmong might have been due to the cleansing flights of Asian honey bees.
- These bees periodically defecate en masse, creating a shower of pollen appearing as a yellowish brown rain.
- Charles Darwin was the first scientist to write about this event; a modern account was published in a Chinese journal in 1977.

- They concluded that the evidence examined did not support a claim of chemical or toxin weapons attack, and they determined that Yellow Rain was a natural occurrence attributable to bees.
- The bee theory applied only to the reports of Yellow Rain in Southeast Asia; it did not address CBW claims in Afghanistan, where bee cleansing flights are not known to occur.

Methods

- Three main bodies of evidence were reviewed for this project: 8,529 pages of United States government documents, declassified by the Defense Intelligence Agency and released through a Freedom of Information Act request, including medical records, laboratory reports, diplomatic communications, internal memos, and protocols originating primarily from the Armed Forces Medical Intelligence Center; over 800 documents of previously published material on Yellow Rain, mycotoxins, and chemical weapons; and interviews with 48 individuals with expert knowledge related to Yellow Rain, including 20 who were directly involved in investigating allegations for either the United States, an NGO, or another country.

- We devised a seven-step strategy for integrating the complex mixture of qualitative and quantitative data and for then establishing in a transparent fashion that one among a range of plausible hypotheses was best supported by available evidence.
- The first step was to divide the evidence into blocks or types of information.
- The second step was to assign to each evidence block a *veritas* ranking based on a combination of what we refer to as degree of dubiousness and degree of fallacy.
- The distinction between these notions is that determining degree of dubiousness requires an appraisal of intrinsic ambiguity or likelihood, whereas determining degree of fallacy requires an appraisal of deception — meaning here the purposeful introduction of falsity.

- The third step was to develop groups of hypotheses, meaning that multiple plausible possibilities were formally considered and counterfactual explanations explored, so as to build into our method a forced reduction in investigator bias.
- The fourth step was to assess each evidence block for the strength of association to each hypothesis, assigning a ranking of strong, medium, or weak.
- The fifth step was to organize the evidence blocks by hypothesis into a matrix based on strength of association and *veritas* rank.

- Strength of evidence was reexamined by grouping blocks, where appropriate.
- The sixth step was to choose the strongest hypothesis based on quality of evidence, quantity of evidence, and strength of explanation based on evidence.
- While it was often possible to determine the strongest hypothesis visually, comparing competing hypotheses numerically was helpful.
- To accomplish this comparison, each block was assigned a numerical score in accordance with a coding scheme attached to the strength of association and *veritas* rank for each hypothesis (Table 1).

Table 1. Scoring for strength of evidence block's association with a hypothesis and *veritas* rank.

<i>An evidence block's association with a hypothesis</i>	<i>Veritas rank</i>		
	<i>High</i>	<i>Medium</i>	<i>Low</i>
Strong	10	8	4
Medium	8	6	2
Weak	4	2	0

Darkly shaded cells show relatively strong support.
Lightly shaded cells show minimally strong support.

- We then employ six summary statistics:
 1. maximum score over all evidence blocks;
 2. minimum score over all evidence blocks;
 3. average score;
 4. average score over evidence blocks in “minimally-strong-support” cells;
 5. average score over evidence blocks in “relatively-strong support” cells;
 6. and percent of evidence blocks in “relatively-strong-support” cells.
- These statistics were applied to the set of evidence blocks relevant to each individual hypothesis, to pairs of hypotheses, and to all hypotheses simultaneously, to produce a numerical and visual representation of hypotheses by strength of support.

- We utilized evidence from an investigation led by Matthew Meselson as assembled in a book by Jeanne Guillemin, *Anthrax: The Investigation of a Deadly Outbreak*.
- Additionally, we found that the selection of evidence blocks, the *veritas* ranking and the generation and selection of hypotheses were not devoid of researcher bias and that this bias could greatly affect the evaluation and interpretation of evidence.

Results

- We divided all available Yellow Rain information from the investigation conducted by the United States government into 12 blocks separated by type and source, representing a course-grained division of evidence (Table 2).
- Block 11 (Conduct of investigation) and Block 12 (Sampling methods) by themselves did not provide evidence to support a given hypothesis, but influenced the analysis of evidence.

1. Samples, medical records, and testimony prior to 1983 were more reliable than those from 1983 on, when the investigation was compromised by refugees' knowledge of incentives to claim victim status and by searching for indicators of attacks, rather than coordinating intelligence data and refugee reports to locate attack sites.
2. Between 1979 and 1982, refugee reports of attacks were consistent with other intelligence data, including known battles and flight paths of aircraft, more than 60 percent of the time.
3. Clinical complaints and findings among self-described victims and detailed refugee accounts of attacks were sufficiently similar in Laos, Cambodia, and Afghanistan to suggest a key common factor, most plausibly a Soviet link, in influence and support of direct operational involvement.

Table 2. Yellow-rain evidence blocks.

E1 Toxicological analysis	E5 Intelligence reports	E9 Hmong interviews
E2 Medical records	E6 Soviet-link evidence	E10 Investigator interviews
E3 Attack data	E7 Coincidence analysis	E11 Conduct of investigation
E4 Autopsy results	E8 Open-source reports	E12 Sampling methods

4. Clinical complaints and findings of alleged victims as documented by photographs, medical records, autopsy results, and third-hand accounts are consistent with mass simultaneous poisoning and not with any known natural disease endemic to Laos, Cambodia, or Afghanistan or with the potential to affect multiple individuals simultaneously. Signs and symptoms reported by alleged victims and eye witnesses, however, were consistent with trichothecene mycotoxin poisoning but also shared features of exposure to nerve gases, riot control agents, phosgene, and arsines.

5. We captured detailed information on 766 separate alleged attacks in Laos, Cambodia, Afghanistan, and Thailand from 1975 through 1985 (Figure 1). Attacks were reported to occur in all months of the year, varying more by season in Laos and Cambodia than in Afghanistan (Figure 2). The locations of the reported attacks were consistent with the locations of Hmong, Khmer and Mujahadin, including the few claims in Thailand, whose border area hosted refugees and guerilla groups. (Figure 3 and 4)

6. Approximately 75 percent of alleged attacks involved seeing or hearing a helicopter or airplane, followed by seeing or smelling a gas or powder fall to the ground.

- The remainder cited landmines, grenades, pipes, artillery, and contaminated food or water.
- The most common color reported in association with gas or powder was yellow (57 percent), but other colors were also described.
- Yellow accounted for almost 70 percent of reports from Laos, but only 48 percent from Cambodia, and 20 percent from Afghanistan.

7. Biomedical samples were collected from 170 alleged victims; samples from only 146 people were analyzed.

- These samples were of blood, urine, and tissue rendered from autopsies.
- Twenty-six of 146 people were positive for trichothecene mycotoxin; these 26 were from 11 sites in Laos and 5 in Cambodia.
- All control samples analyzed as part of the United States Government investigation were negative for trichothecene mycotoxin.

8. Samples were determined to be positive for trichothecene mycotoxin if they met the following criteria established by the Armed Forces Medical Intelligence Center.

- Multiple specimens had to contain both T2, a highly toxic stable trichothecene mycotoxin, and HT2, a metabolite of T2.30
- Positive blood samples had to be confirmed by a positive urine sample or highly credible intelligence report of an attack. Data from certain laboratories could not be considered alone; their reports had to be confirmed by another laboratory on a blinded basis.
- Older samples were given less weight than newer samples, as older samples were at greater risk of degradation.
- Absent any known clinical complaints and findings, “victim” status, laboratory results notwithstanding, had to be reassessed.

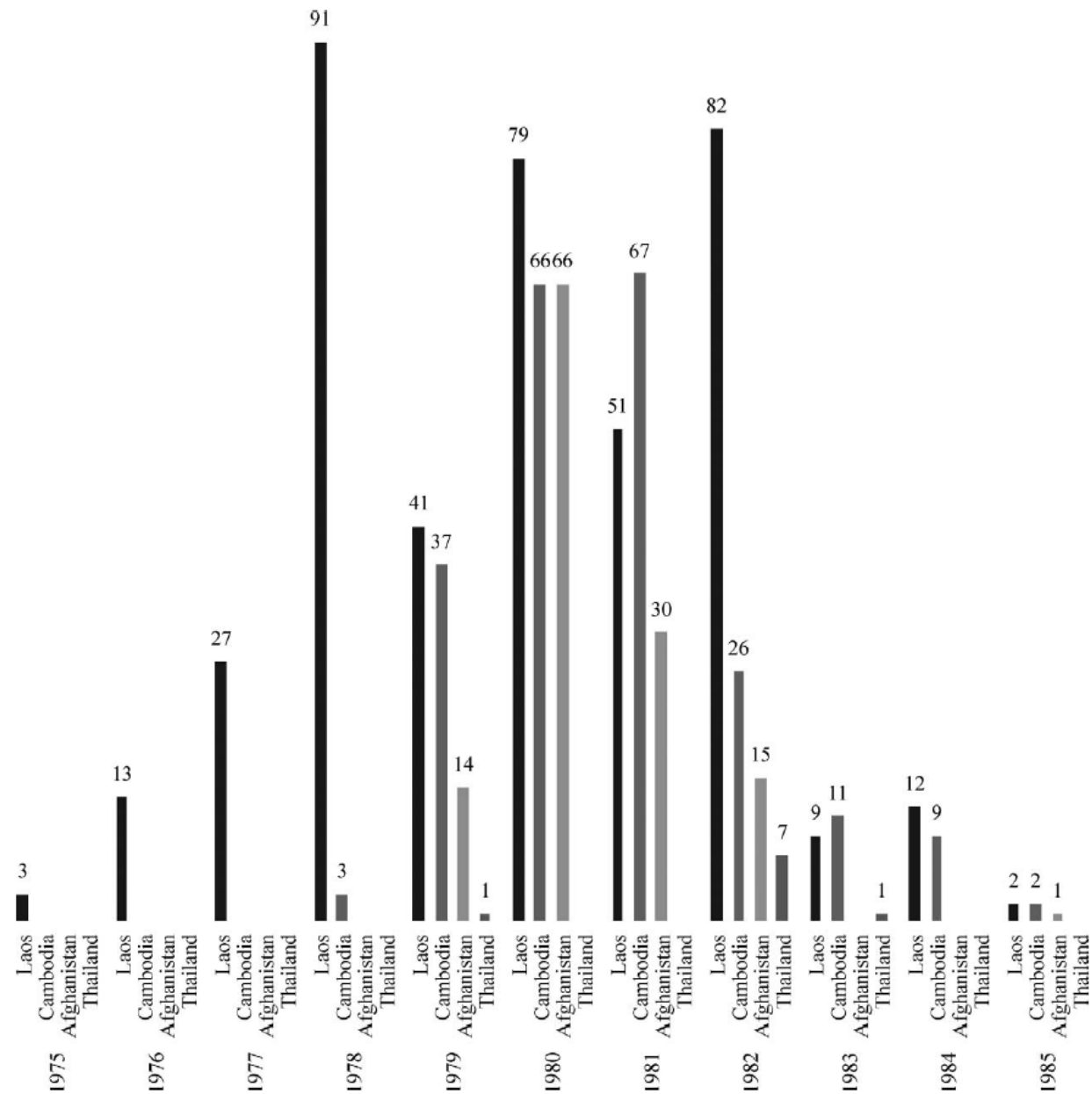


Figure 1. Reported Yellow Rain attacks, by year and location.

9. Problems associated with the sampling and handling of samples, lack of chain-of-custody documentation, paucity of human controls, difficulty in ascertaining appropriate environmental controls, and lack of baseline toxicological data on populations and the environment in Southeast Asia and Afghanistan combine to mean that we cannot determine with certainty that laboratory findings positive for trichothecene mycotoxin in both biomedical and environmental samples following Yellow Rain claims were consequences of intentional attack.

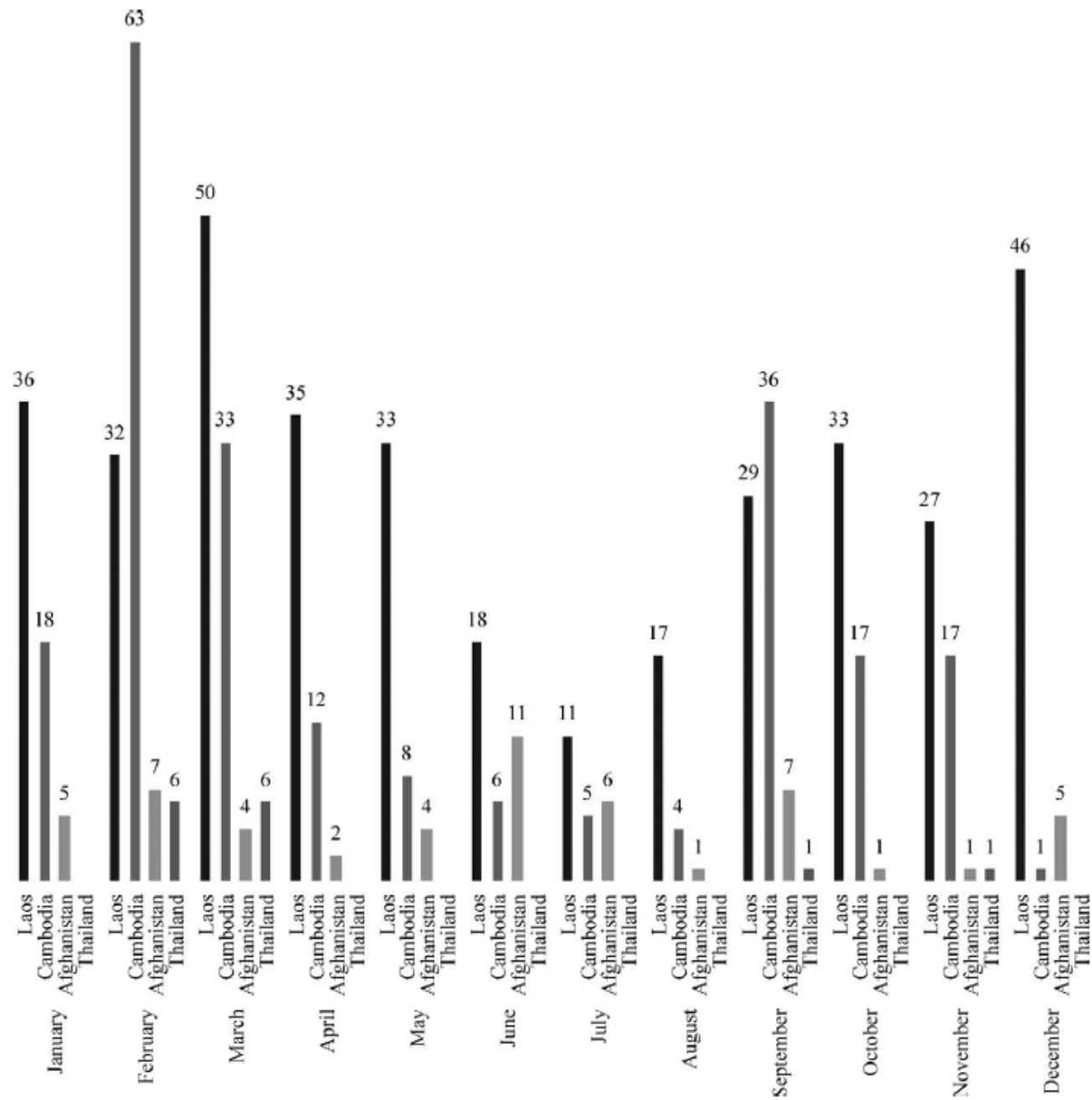


Figure 2. Reported Yellow Rain attacks, 1975–1985, by month and location.

10. When we examined all 12 evidence blocks for consistency with the bee theory, we found that some, but not all, of the environmental samples contained pollen.

- Some of the environmental samples that tested positive for T2 did not contain pollen.
- The bee theory provides no explanation for the presence of T2 in biomedical samples from alleged victims.
- The bee theory does not address the 63 percent of reported air attacks that were not associated with the color yellow, nor the 25 percent of all reported attacks that did not involve an air assault.
- The bee theory does not account for the 69 attacks alleged to have occurred in Afghanistan, nor does it explain the morbidity and mortality experienced by the Hmong, Khmer, and Mujahadin.

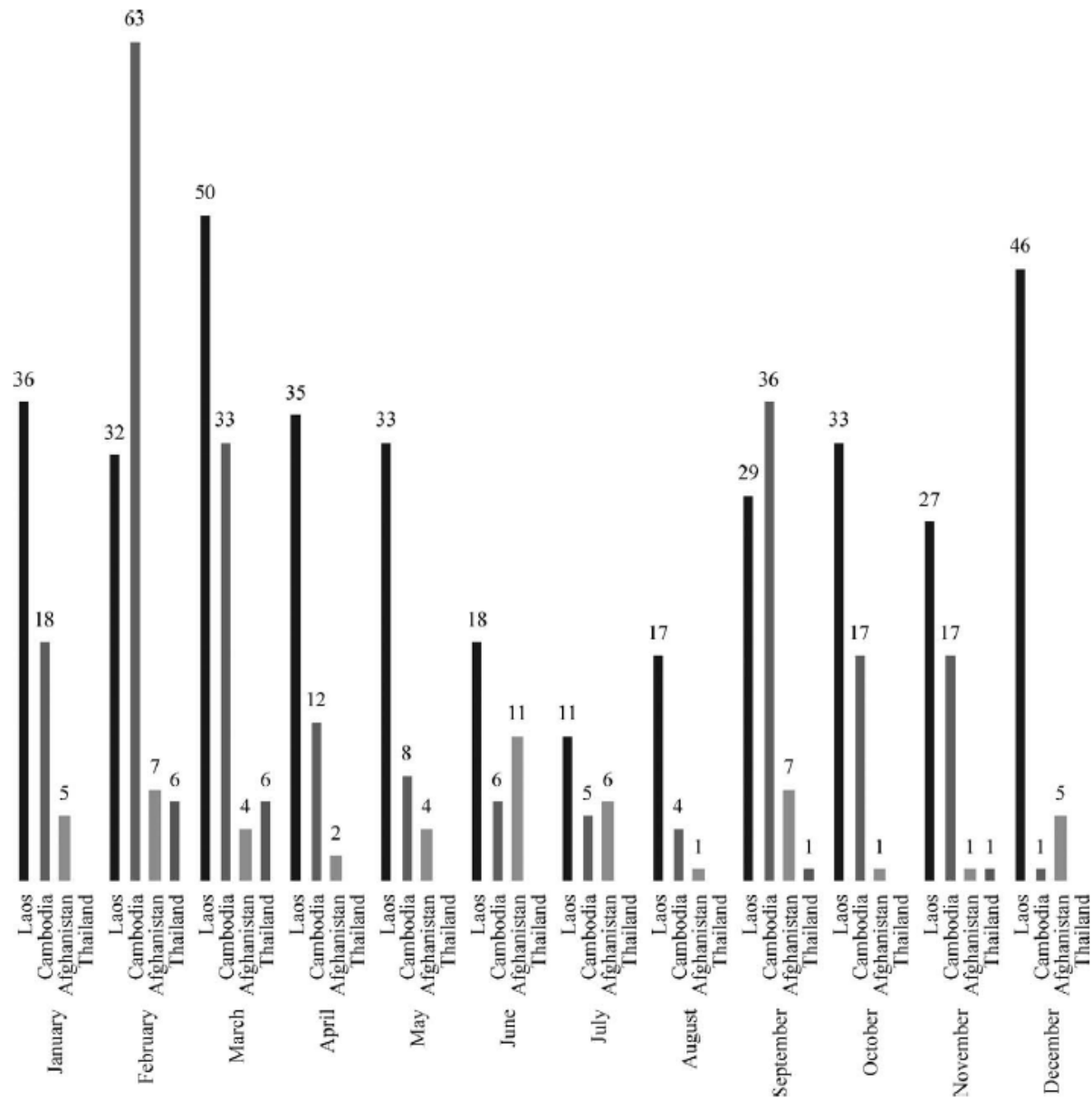


Figure 2. Reported Yellow Rain attacks, 1975–1985, by month and location.

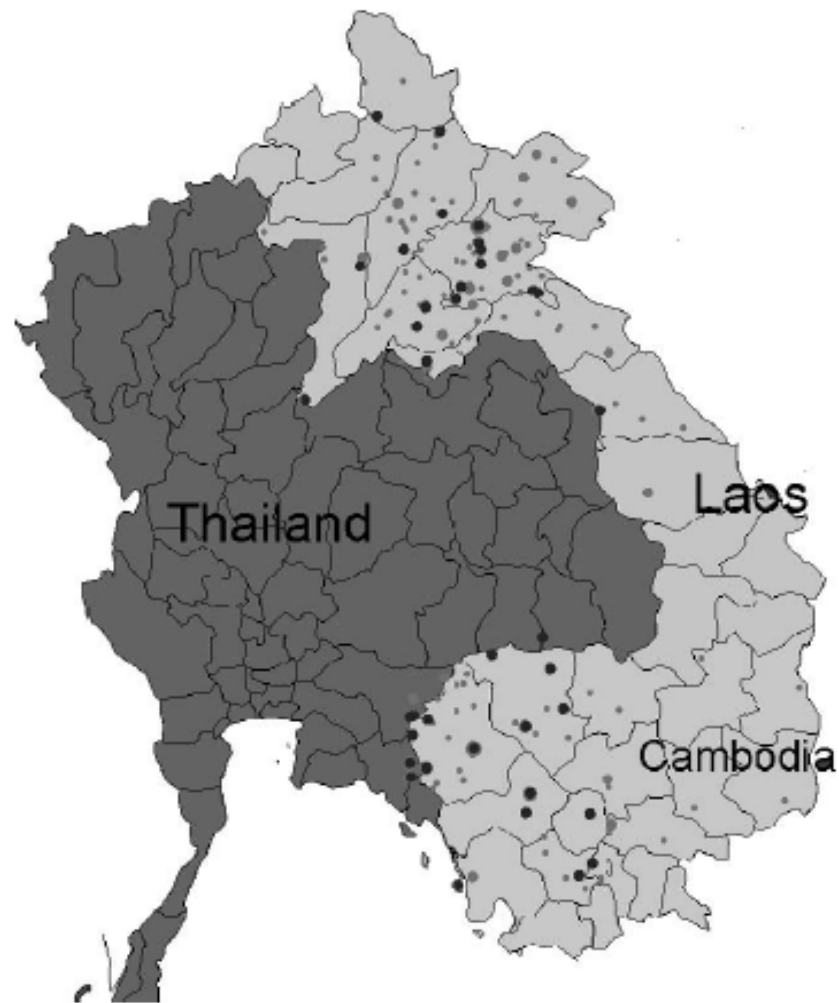


Figure 3. Reported Yellow Rain attacks, 1976–1984, in Laos, Cambodia, and Thailand. Gray dots are proportional in size to number of claims, ranging from 1 to a high of 25 (in a single year). Black dots show claim sites at which multiple sources concurred that an attack took place.

- The next step in our methodology was to apply to each evidence block a *veritas* rank based on a combination of dubiousness and fallacy.
- Dubiousness relates to anything that might cause distortion, error, or divergence.
- Divergence may be due to systematic errors of measurement and sources of bias, e.g. selection bias or recall bias.
- We scored “degree of dubiousness” according to the probability of high (1), moderate (2), or minimal (3) distortion.

- “Degree of fallacy” referred to the extent to which a piece of evidence was deceptive, misleading, or the result of unreliable reasoning and was scored as follows:
 - 1, if the event’s probability was low and evidence for its occurrence doubtful;
 - 2, if supporting information was accurate but event probability low;
 - 3, if we accepted the evidence but doubted a piece of it; and
 - 4, if we accepted all evidence as probably accurate.
- The overall *veritas* score was (degree of dubiousness) 1 (degree of fallacy).

- The *veritas* rank was called high if the *veritas* score was 6 or 7; medium if the score was 4 or 5; and low if the score was 2 or 3.
- Table 3 includes the dubiousness, fallacy, and overall *veritas* scores for each of the evidence blocks.
- The details of the evidence contained in each block, the analysis of that evidence, and the rationale for each score can be found in the author's (RK) dissertation.

- The *veritas* rank was called high if the *veritas* score was 6 or 7; medium if the score was 4 or 5; and low if the score was 2 or 3.
- Table 3 includes the dubiousness, fallacy, and overall *veritas* scores for each of the evidence blocks.
- The details of the evidence contained in each block, the analysis of that evidence, and the rationale for each score can be found in the author's (RK) dissertation.
- Once evidence blocks were assigned *veritas* rankings, hypotheses were developed to test explanations for Yellow Rain claims.
- We determined three rival hypotheses and numerous subsidiary hypotheses to be plausible candidates for consideration (Table 4).

- If a chemical or toxin agent had been used intentionally (H1), then what was the composition of the agent (H1A), what were its users' intentions (H1B), and who might its users and their sponsors have been (H1C)?
- Testing the second hypothesis (H2), that Yellow Rain was a naturally occurring event, would necessitate determining which pieces of evidence in the Yellow Rain investigation seemed plausible and how those events might be explained through natural events.
- Visual accounts of Yellow Rain could be due to bee cleansing flights (H2A) as described by Meselson and colleagues.
- Findings of trichothecene mycotoxins in the areas of interest could be due to natural levels of fungi in the region (H2B).
- A possible explanation evaluated was the elephant grass theory (H2C), as presented to the United Nations by the Soviet Union Academies of Science, asserting that American use of defoliants in Vietnam resulted in region-wide overgrowth of elephant grass.



Figure 4. Reported Yellow Rain attacks, 1979–1984, in Afghanistan. Gray dots are proportional in size to number of claims. Black dots show claim sites at which multiple sources concurred that an attack took place.

- The third hypothesis (H3), that events were fabricated, rejects refugee reports of Yellow Rain, as well as morbidity and mortality data and findings of mycotoxins in favor of two possible explanations.
- The first (H3A) is that the events were fabricated in confusion, ignorance, or mass hysteria.
- The second (H3B) is that the events were fabricated in order to gain political favor or asylum either by refugees themselves, regional political groups, or by the United States intelligence community.

- With scores and rankings completed, we organized evidence blocks by hypothesis, and arranged them in matrices (Figures 5a, 5b, and 5c).
- We then re-evaluated the material by grouping evidence blocks where appropriate.
- For example, information on the conduct of the investigation and sampling methods dilute the strength of the toxicology findings, defensibility of conclusions from medical records, and quality of some of the attack data derived from interviews.
- Conversely, evidence provided by the attack data is supported by the medical records, coincidence analysis, intelligence reports and interviews.

Table 3. *Veritas* score and *veritas* rank, by evidence block.

<i>Evidence block</i>	<i>Degree of dubiousness</i>		<i>Degree of fallacy</i>		<i>Veritas score</i>		<i>Veritas rank</i>
E1 Toxicological analysis	3	+	3	=	6	⇒	High
E2 Medical records	2	+	3	=	5	⇒	Medium
E3 Attack data	2	+	2 to 3	=	4 to 5	⇒	Medium
E4 Autopsy results	2	+	4	=	6	⇒	High
E5 Intelligence reports							
a. Human source	1	+	2	=	3	⇒	Low
b. Intercepts and imagery	3	+	3	=	6	⇒	High
E6 Soviet-link evidence	1 to 2	+	3	=	4 to 5	⇒	Medium
E7 Coincidence analysis	2	+	3	=	5	⇒	Medium
E8 Open-source reports	1	+	3	=	4	⇒	Medium
E9 Hmong interviews	1	+	3	=	4	⇒	Medium
E10 Investigator interviews	1	+	3	=	4	⇒	Medium
E11 Conduct of investigation	3	+	4	=	7	⇒	High
E12 Sampling methods	3	+	4	=	7	⇒	High

Table 4. Yellow Rain hypotheses.

H1: Chemical or toxin agents used intentionally in Laos, Cambodia, and Afghanistan, 1975–1985

H1A: Composition

Included trichothecene mycotoxin
Same composition in all countries

H1B: Intent

Intent to kill and injure
Intent to frighten
Intent to target animals, crops, foliage
Intent to experiment

H1C: Responsible party

Soviet Union
Other states

H2: “Yellow Rain” was a naturally occurring event.

H2A: Visual accounts of Yellow Rain due to natural causes
(bee theory)

H2B: Toxicological findings of mycotoxins due to natural levels
of *Fusarium* in region

H2C: Elephant grass indirectly increased natural levels of
trichothecene mycotoxins

H2D: Morbidity and mortality due to causes unrelated to
Yellow Rain

H3: Events fabricated

H3A: Incorrect explanations invented in confusion, ignorance,
or mass hysteria

H3B: Events fabricated to gain asylum or political favor

- The strongest hypothesis was chosen based on a visual examination of the matrices and also through scoring and combining the evidence.
- In particular, each evidence block was assigned a numerical score in accordance with the coding scheme shown in Figures 5a, 5b, and 5c.
- Cells in the upper left sections of these tables, where both *veritas* and association rankings are medium or higher, were interpreted to represent relatively strong support for a given hypothesis.
- Cells on the right-hand and bottom borders, where at least one of the support or *veritas* rankings was low, were interpreted as categories of minimal support, as described in Table 1.
- All values assigned to the upper-left section of the table were at or above the mid-point on the numerical scale, thereby reflecting “relatively strong” support.

- The chosen hypothesis, that CBW attacks occurred in Southeast Asia and Afghanistan, was evaluated to ensure it met guidelines for causation, that it agreed with the state of knowledge, and that it was consistent with any definitive proof or admission that might be available.
- For a check against the state of knowledge, the evidence was evaluated to ensure it was consistent with what is known about intentional and accidental releases of CBW agents, as opposed to natural occurrence of disease.

Table 5. Strength of association, with rationale, by evidence block.

<i>Evidence block</i>	<i>Strength of association for hypothesis</i>			<i>Rationale</i>
	<i>H1 (Attacks intentional)</i>	<i>H2 (Exposures natural)</i>	<i>H3 (Events fabricated)</i>	
E1 Toxicological analysis	Medium	Medium	Medium	Mycotoxins were found, but the sample analysis program could not conclusively say they were not from the environment.
E2 Medical records	Strong	Weak	None	Clinical complaints and findings were consistent with exposure to a chemical or toxin attack, but it is possible that symptoms were of natural origin. Illness and death, however, were real and not fabricated.
E3 Attack data	Strong	None	None	Detailed information on each claimed attack gave strong support for attacks having taken place and gave no support for other hypotheses.
E4 Autopsy results	Medium	Medium	None	Autopsies demonstrated large toxin loads at death, but toxin origin could not be clarified. Fabrication not supported.
E5 Intelligence reports a. Human source b. Intercepts and imagery	Strong	None	Weak	Intelligence reports strongly supported intentional attack, but some reports could have been fabricated. No support for natural exposure.
E6 Soviet-link evidence	Strong	None	None	Evidence consistent with a Soviet link to attacks in Laos, Cambodia, Thai borderlands, and Afghanistan supported intentional attack strongly and exclusively.
E7 Coincidence analysis	Strong	Weak	Weak	Consistencies among claims in Laos, Cambodia, Thai borderlands, and Afghanistan strongly supported intentional attack but also offered support to natural exposure (if plausible in two dissimilar regions) and fabrication (if plausible in two distant regions).
E8 Open-source reports	Medium	Medium	Weak	Open-source reporting offered some support for each hypothesis.
E9 Hmong interviews	Strong	Medium	Weak	Hmong interviews strongly supported intentional attack, but some content was not inconsistent with natural exposure. Fabrication seemed unlikely.
E10 Investigator interviews	Strong	Medium	None	Investigator interviews found evidence strongly suggesting intentional attack but not precluding natural exposure. No content from the interviews suggested fabrication.
E11 Conduct of investigation	None	None	None	Neither E11 nor E12 supports any hypothesis, but each becomes important when grouped with other evidence.
E12 Sampling methods	None	None	None	

Hypothesis 1 <i>Attacks intentional</i>			
	<i>High veritas</i>	<i>Medium veritas</i>	<i>Low veritas</i>
Strong association	E5a Intelligence reports: Human source	E10 Investigator interviews E9 Hmong interviews E7 Coincidence analysis E6 Soviet-link evidence	E2 Medical records E3 Attack data E5b Intelligence reports: Intercepts and imagery
Medium association	E4 Autopsy results E1 Toxicological analysis	E8 Open-source reports	
Weak association			

Figure 5a. Evidence blocks by *veritas* rank and strength of association with Hypothesis 1.

- Lastly, we checked our hypothesis against definitive proof or admission.
- Regardless of how much evidence there is for or against the use of chemical or toxin agents in Southeast Asia and Afghanistan in the late 1970s and early 1980s, no definitive proof is available.
- Nothing in the evidence collected during the investigation meets the requirement of “definitive” proof, and, since the biomedical and environmental samples from the investigation were destroyed, there is no way to go back and revisit the evidence for further clues.

Discussion

<p style="text-align: center;">Hypothesis 2 <i>Exposures natural</i></p>			
	<i>High veritas</i>	<i>Medium veritas</i>	<i>Low veritas</i>
Strong association			
Medium association	<p>E1 Toxicological analysis</p> <p>E4 Autopsy results</p>	<p>E8 Open-source reports</p> <p>E9 Hmong interviews</p> <p>E10 Investigator interviews</p>	
Weak association		<p>E2 Medical records</p> <p>E7 Coincidence analysis</p>	

Figure 5b. Evidence blocks by *veritas* rank and strength of association with Hypothesis 2.

- On the basis of evidence at hand, we conclude that lethal chemical or toxin compounds were used in Laos, Cambodia, in Thai borderlands, and Afghanistan, in violation of the international conventions operative during the 1970s and 1980s.
- We cannot, however, identify the specific agents used, the intent, or the root source or sources of the attacks.
- The evidence analyzed here suggests — but only suggests — an association between reports and exposures.

		Hypothesis 2 <i>Exposures natural</i>		
		<i>High veritas</i>	<i>Medium veritas</i>	<i>Low veritas</i>
Strong association				
Medium association				
		E4 Autopsy results E1 Toxicological analysis	E8 Open-source reports E9 Hmong interviews E10 Investigator interviews	
Weak association				
			E2 Medical records E7 Coincidence analysis	

Figure 5b. Evidence blocks by *veritas* rank and strength of association with Hypothesis 2.

Hypothesis 3 <i>Events fabricated</i>				
		<i>High veracity</i>	<i>Medium veracity</i>	<i>Low veracity</i>
Strong association				
	Medium association	E1 Toxicological analysis		
		Weak association	E5a Intelligence reports: Human source	E7 Coincidence analysis E8 Open-source reports E9 Hmong interviews

Figure 5c. Evidence blocks by *veritas* rank and strength of association with Hypothesis 3.

- Of particular relevance to CBW investigations based on heterogeneous sets of documents is a sub-field of AI called information extraction (IE).
- This area was heavily promoted in the late 1980s in the United States under the auspices of the Defense Advanced Research Projects Agency (DARPA), but its origins were in the Linguistic String Project at New York University, where Naomi Sager advanced the work of Zellig Harris.
- Running roughly in parallel was Roger Schank, who studied story comprehension.
- Stories followed certain stereotyped patterns, referred to as scripts. Knowing “the script,” language analyzers were able to fill in details and make inferential leaps where information required to make a leap was not present in the text examined.

- Of particular relevance to CBW investigations based on heterogeneous sets of documents is a sub-field of AI called information extraction (IE).
- This area was heavily promoted in the late 1980s in the United States under the auspices of the Defense Advanced Research Projects Agency (DARPA), but its origins were in the Linguistic String Project at New York University, where Naomi Sager advanced the work of Zellig Harris.
- Running roughly in parallel was Roger Schank, who studied story comprehension.
- Stories followed certain stereotyped patterns, referred to as scripts. Knowing “the script,” language analyzers were able to fill in details and make inferential leaps where information required to make a leap was not present in the text examined.



Figure 6. Laotian child said to be a victim of Yellow Rain. Rash was confined to the right side of the body, reportedly the side exposed to attack.

- Gerald de Jong designed and built the first system based on this idea, FRUMP.
- It was used to extract information from news stories, clearly one of the important and difficult domains that arise in CBW investigations.
- This work has been complemented by a long series of “Message Understanding Conferences” (MUCs) running from the 1980s to the present and focusing on information extraction in the context of naval intelligence.
- A second broad topic that induces discomfort in readers of conclusions derived from CBW investigations — e.g., the “Results” above — is that they represent the culmination of causal inferences from single, novel events. The method underlying this culmination would seem to fly in the face of a large literature going back to David Hume.

Table 6. Summary statistics.

A. Hypotheses evaluated separately						
Statistic	H ₁	H ₂	H ₃			
Maximum	10	8	8			
Minimum	4	2	0			
Average	7.64	5.42	3			
Average over minimum-support cells	4	2	2			
Average over strong-support cells	8	6.8	8			
Percent of evidence blocks in strong-support cells	91	75	16.7			
H1: E1, E2, E3, E4, E5, E6, E7, E8, E9, E10						
H2: E1, E2, E4, E7, E8, E9, E10						
H3: E1, E5, E7, E8, E9						
B. Comparative scores based on pairwise overlapping blocks						
Evaluated pairs	H ₁ AND H ₂		H ₁ AND H ₃		H ₂ AND H ₃	
Statistic	H ₁	H ₂	H ₁	H ₃	H ₂	H ₃
Maximum	8	8	10	8	8	8
Minimum	6	2	4	0	2	2
Average	7.7	5.42	7.3	3	5.5	3
Average over minimum-support cells	2	2	2	2	—	—
Average over strong-support cells	8	7.3	7.3	8	7	8
Percent of evidence blocks in strong-support cells	100	60	100	17	67	33
H1 AND H2: E1, E2, E4, E7, E8, E9, E10						
H1 AND H3: E1, E5, E7, E8, E9						
H2 AND H3: E1, E7, E8, E9						
C. Comparative scores based on evidence blocks common to all three hypotheses						
Statistic	H ₁	H ₂	H ₃			
Maximum	8	8	8			
Minimum	6	2	2			
Average	7.3	5.5	3.5			
Average over minimum-support cells	2	2				
Average over strong-support cells	7.3	7	8			
Percent of evidence blocks in strong-support cells	100	67	33			
Blocks common to all three: E1, E7, E8, E9						