

VIETNAM:  
PROGRESS OF  
THE CHEMICAL WAR

/ J. B. Neilands

In March, 1965, the *New York Times* and other media carried the first announcement of the use of various anti-personnel gases in Vietnam.<sup>1</sup> The nature of the gases was not initially disclosed, but a spokesman for the Administration described them as tear gases mixed with nauseating agents.<sup>2</sup> The announcement ignited an international uproar and Secretary Rusk was obliged to offer his opinion that riot-control agents were not banned by the 1925 Geneva Protocol. Robert McNamara reported that the three gases in use were CN, CS, and DM.<sup>3</sup> Procurement figures—i.e., an order for 2.1 million pounds of CS was placed in late 1968—suggested that the anti-personnel gases have been institutionalized in the Vietnam weapons arsenal.<sup>4</sup>

The defoliation program is better known on the American scene both in the general public and within the scientific community.<sup>5</sup> The operation destined to be named "Ranch Hand" began on a modest scale in 1962 and escalated sharply to a maximum area of 1.7 million acres sprayed in 1967.<sup>6</sup> The area treated diminished somewhat in 1968 as a consequence of the general havoc resulting from the Tet offensive of that year; figures for 1969 are not available. Three main types of herbicides are sprayed, namely, "orange/purple," "blue," and "white." Each type of herbicide is color-coded with a stripe painted around each drum. The three colors refer to

<sup>1</sup>*New York Times*, March 23, 1965.

<sup>2</sup>*Ibid.*, March 25, 1965.

<sup>3</sup>Jack Raymond, *Army*, May, 1965; and Elinor Langer, *Science*, Vol. 155 (January 20, 1967), p. 299.

<sup>4</sup>*Chemical and Engineering News*, November 11, 1968, p. 27. Procurement figures published in the *Congressional Record*, April 21, 1969, show \$81 million budgeted for riot control munitions in Fiscal 1969. In July, 1969, the Senate Armed Services Committee trimmed \$16 million from the military appropriations for offensive chemical and biological warfare agents (*Chemical and Engineering News*, July 14, 1969, p. 85). See also a statement by Professor M. Meselson on CS procurement for Vietnam as reported by the *Chronicle*, (San Francisco) July 25, 1969.

<sup>5</sup>Arthur Galston, *Scientist and Citizen*, 9:7, (1967), p. 122.

<sup>6</sup>Midwest Research Institute (MRI) Report, "Assessment of Ecological Effects of Extensive or Repeated Use of Herbicides," available from the Department of Commerce, Clearinghouse for Scientific and Technical Information, Port Royal Road, Springfield, Virginia.

formulations of phenoxyacetic acids (2,4-D and 2,4,5-T), cacodylic acid and picloram (or Tordon), respectively. The Department of Defense (DOD) commandeered the entire U.S. production of 2,4,5-T for 1967 and 1968, an amount estimated as between 13 and 14 million pounds.<sup>7</sup>

### LEGAL QUESTIONS

Does the use of "non-lethal" gases and herbicides in Vietnam constitute chemical warfare? Is it a violation of international law? Should napalm and white phosphorus be considered as chemical (or otherwise prohibited) weapons?

U.S. Army manuals classify as agents of chemical warfare the three gases used in Vietnam and all sprays which destroy cover and deny food to the enemy.<sup>8</sup> The generals in the Chemical Corps and their colleagues in the U.S. chemical industry have long advocated elimination of all taboos on the use of chemical weapons.<sup>9</sup>

Chemical warfare on a massive scale was first employed in World War I and it is estimated that more than 1,000,000 people were affected, of which 100,000 were fatalities.<sup>10</sup> The universal horror engendered by the use of phosgene, chlorine and mustard gas in that war—and these are relatively mild compounds compared to the nerve gases of today—led to the adoption of the 1925 Geneva Protocol. The U.S. furnished the initiative for this conference and the agreement was promptly signed by our representatives at Geneva. However, active lobbying by special interest groups—namely, veterans organizations, the military, and the chemical industry—blocked the measure in the Senate with the result that it has not to this day been ratified by the U.S. Together with Japan, we are the only major nation in the world to have failed to support this important instrument.

The Geneva Protocol, written almost half a century ago, is comprehensive in scope.<sup>11</sup> Biological weapons were included in an extension of the prohibition via the appended phrase ". . . bacteriological methods of warfare . . .;" however, it may someday be necessary to amend this by adding specific reference to viruses. On the other hand, the treatment of chemicals is all-inclusive. Thus the substantive portion of the Protocol states: "Whereas

<sup>7</sup>See letter from Thomas O. Perry, *Science*, Vol. 160 (May 10, 1968), p. 601.

<sup>8</sup>FM 3-8, *Chemical Reference Handbook*, Department of the Army, January 1967; FM 3-10, *Employment of Chemical and Biological Agents*, Departments of the Army, Navy and Air Force, March 1966. According to *Law of Land Warfare*, FM 27-10 (1956); "It is especially forbidden to employ poison or poisoned weapons . . . Discussion of this rule. The foregoing rule does not prohibit measures to destroy . . . through chemical or bacterial agents harmless to man, crops intended solely for consumption by the armed forces (if that fact can be determined)."

<sup>9</sup>Seymour Hersh, *Chemical and Biological Warfare*, New York: Bobbs-Merrill, 1968; and Frederic J. Brown, *Chemical Warfare*, Princeton: Princeton University Press, 1968.

<sup>10</sup>A. M. Prentiss, *Chemicals in War*, New York: McGraw-Hill, 1937.

<sup>11</sup>The substantive text of the Geneva Protocol, together with a list of subscribing nations prior to World War II, was published by *Scientist and Citizen*, Vol. 9, No. 7, 1967, p. 135.

the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilized world . . .". The U.S. Army has a "hard line" on the Protocol and the various Field Manuals point out that ". . . the United States is not a party to any treaty now in force that prohibits or restricts the use in warfare of toxic or nontoxic gases, or smoke, or incendiary materials, or of bacteriological warfare . . .".<sup>12</sup> In recent times, however, the State Department has read the Geneva Protocol as prohibiting only lethal gases and hence not applicable to the "riot control" agents in use in Vietnam.<sup>13</sup> The text of the Protocol, as quoted above, makes no such distinction.

A British statesman intimately familiar with the history of the Geneva Protocol, Philip Noel-Baker, has commented: "I find it difficult to understand how anyone can argue that the Protocol permits the use of 'harassing' gases and herbicides."<sup>14</sup> The Political Committee of the General Assembly of the United Nations has approved a Swedish resolution which declares that the Geneva Protocol applies to the use of "any chemical agents." The vote was 58 for, 35 abstentions and 3 against. The latter votes were cast by Australia, Portugal and the United States. The vote was rejected by the State Department on the grounds that there were too many abstentions.<sup>16</sup> The British Government, which abstained, was reported to be under pressure from the U.S. to vote "no" or, at the very least, abstain.<sup>16</sup>

The U.S. had established—until Vietnam—a consistent history of respect for the Geneva Protocol. President Roosevelt was at pains to denounce all attempts to legitimize gas warfare and he vetoed a bill to change the name of the Chemical Warfare Service to the "Chemical Corps." Two years after his death the change was put through. On June 8, 1943, Roosevelt had declared: "I state categorically that we shall under no circumstances resort to the use of such (CBW) weapons unless they are first used by our enemies." Admiral William Leahy, Chief of Staff, considered poison gas to be a "barbarous weapon" and he had this to say about a proposal, made in 1944, to employ biological agents to destroy the Japanese rice crop: ". . . (it) would violate every Christian ethic I have ever heard of and all of the known laws of war . . .".<sup>17</sup> On December 5, 1966, the United Nations adopted a resolu-

---

<sup>12</sup>J. H. Rothschild, *Tomorrow's Weapons—Chemical and Biological*, New York: McGraw-Hill, 1964.

<sup>13</sup>*U.S. News and World Report*, April 5, 1965.

<sup>14</sup>*New York Times*, December 9, 1969.

<sup>15</sup>*Ibid.*, December 12, 1969.

<sup>16</sup>*The Observer* (London), November 30, 1969.

<sup>17</sup>Frederic J. Brown, *op. cit.*

tion, supported by the U.S., which called on all States to adhere to the Protocol.<sup>18</sup> The latter has thus acquired a kind of universal status—42 nations ratified prior to World War II and since then the number has increased to 60—and some international lawyers have argued that the U.S. is accordingly culpable even in the absence of a formal signature.<sup>19</sup>

President Nixon announced at a White House news conference on November 25 that the Geneva Protocol would be resubmitted to the Senate for ratification. It was made clear, however, that “tear gases” and herbicides would be excepted from the proposed ban on chemical and biological weapons. Only biological agents, and certain incapacitating chemicals, would be prohibited under the U.S. interpretation of the Protocol. Until the matter has been debated and clarified in the Senate the numerous loopholes in the U.S. position renders it difficult to say if the President’s gesture is, as he claims, an “initiative toward peace” or a public relations ploy.

Indeed, the language of the Geneva Protocol is so broad it could conceivably refer to substances such as napalm and white phosphorus. Since napalm is constituted entirely of carbon and hydrogen, it has a prodigious appetite for oxygen during combustion. This removes oxygen from the vicinity and, because of incomplete combustion, generates carbon monoxide, the latter a deadly respiratory poison. White phosphorus is listed as a chemical agent in the Department of the Army Field Manuals. Both of these agents are discussed below in more detail.

### BIOLOGICAL WARFARE

In spite of the proposed ban on biological agents, the toxic products of microorganism were still retained as legitimate weapons. President Nixon, however, subsequently extended the ban on biological weapons to military toxins.<sup>20</sup> There have been no accusations from any quarter that the U.S. has engaged in biological warfare in Vietnam. There is a kind of “natural” biological warfare which follows all armed hostilities, as a consequence of the deterioration of public health facilities, and Vietnam is no exception. Rats, which are vectors of the plague organism, tend to proliferate in the defoliated areas and in the garbage dumps surrounding refugee camps. In 1961 only

<sup>18</sup>In a letter dated June 19, 1967, to Dr. Jay Orear, Chairman of the Federation of American Scientists, the Special Assistant to the President for Science and Technology, Dr. Donald Hornig, cited support for this United Nations resolution as evidence for continuing concern about the problem of Chemical and Biological Warfare. The letter stated: “Our present policy does permit the use in Vietnam of riot control agents that are widely used by police forces throughout the world and herbicides that are commonly employed in many countries.” *Federation of American Scientists Newsletter*, 20:5 (May 1967).

<sup>19</sup>I. Brownlie, *CBW: Chemical and Biological Warfare*, S. Rose (ed.), Boston: Beacon Press, 1969, p. 141; and John Duffett, (ed.), *Against the Crime of Silence*, Flanders, N. J.: O’Hare, 1968. See chapters on international law.

<sup>20</sup>*Chronicle*, December 13 and 16, 1969; *New York Times*, December 16, 1969, and February 15, 1970.

about a half dozen cases of plague were reported in South Vietnam; by 1965 the annual number of reported cases rose to 4500. The year 1967 saw 5500 plague victims in South Vietnam, 350 of whom died. Early estimates by the World Health Organization substantiate these figures and a later, detailed report by the same agency indicated cholera, as well as plague, to be on the increase.<sup>21</sup> A sharp increase in malaria incidence in the U.S. has been traced to a Vietnam parasite imported by returning American servicemen. Similarly, melioidosis has been contracted by GIs in Vietnam and the disease subsequently transmitted to the U.S.<sup>22</sup>

#### NAPALM AND WHITE PHOSPHORUS

Napalm is a purely American invention. It was compounded by Professor Louis Fieser at Harvard University in World War II and has since experienced considerable refinement. The early formulations were metallic soaps gelled with gasoline.<sup>23</sup> In recent years the Air Force has adopted a new type of napalm, designated "Napalm B," which consists of 50% polystyrene mixed with 25% each of gasoline and benzene.<sup>24</sup> This blend, which was developed by the Dow Chemical Company, is said to impart superior qualities of "adhesion" to the product.

It was estimated in 1966 that napalm for Vietnam could consume up to 300 million pounds of polystyrene annually, or 18% of the total U.S. production in that year.<sup>25</sup> At the 1966 price of 14½ cents per pound, the cost of the polystyrene alone used in napalm would amount to \$43 million annually. For a time the demand for polystyrene was such that, to satisfy the Vietnam market, the price was boosted and there was a shortage of certain civilian products containing this plastic.

Napalm was used extensively in the Pacific theatre in World War II, and a total of 32,215 tons was dropped in the three years of the Korean war. Figures released by the Defense Department in early 1968 revealed the napalm escalation in Vietnam: 2181 tons dropped in 1963; 1777 tons in 1964; 17,659 tons in 1965 and 54,670 tons in 1966. For the first six months of 1967, napalm spending came to \$2,949,929 per month. By March of 1968 it was estimated that the Air Force alone had dropped in excess of 100,000 tons in Vietnam; the Navy also uses napalm bombs and the Army employs substantial quantities in flame-throwers.

According to one report, American pilots are "given a square mile on a map and told to hit every hamlet within the area" with napalm bombs.<sup>26</sup>

<sup>21</sup>*Epidemiological Situation in Vietnam*; available from the Regional Office of the World Health Organization, 1525 23rd St., N.W., Washington, D.C.

<sup>22</sup>*Chemical Laboratory Forum*, 1:1, (1969).

<sup>23</sup>L. F. Fieser, *The Scientific Method: A Personal Account of Unusual Projects in War and Peace*, New York: Reinhold, 1964.

<sup>24</sup>*Chemical and Engineering News*, March 14, 1966, p. 24.

<sup>25</sup>*Ibid.*, July 18, 1966, p. 24.

<sup>26</sup>*Washington Post*, March 13, 1965.

A reporter for the San Francisco *Chronicle* flew a bombing mission in a carrier-based Phantom 11F4 and later described his experience:

"... We flattened out over the target... and I had a glimpse of three thatched huts burning along the edge of some water. Then I closed my eyes and could not open them again until we were several thousand feet up. Below, the trees and huts were blotted out by a cloud of nauseous black smoke. . . . On the second run I managed to hold my eyes open. As we pulled out through the smoke, I saw the second napalm bomb a couple of seconds after it had burst. A ball of brilliant flame was rolling out across more than 200 feet, swelling like a giant orange cauliflower. . . . I asked the commander about the target. . . . 'Well, we don't rightly know for sure,' he said. . . . 'You can't rightly see much at those speeds. . . . But most times you can reckon that whatever moves in the Delta is V. C.'"<sup>27</sup>

The indiscriminate use of napalm on hamlets and civilian structures was confirmed by Frank Harvey in his authoritative book *Air War-Vietnam* as well as in other eyewitness reports of the character of the war in the South.<sup>28</sup> There is a dispute about the number of burn casualties which can be ascribed to napalm. Robert Guillain described patients, some of them napalm victims, lying in a hospital in Central South Vietnam:

"There were sometimes two in a bed; now and then three. They were peasants of all ages, badly battered. . . . 'Those that you see here are those that were able to come,' a Vietnamese hospital doctor told me. 'For every one who can reach a town, there are ten who die in the village or the fields or wherever they are struck. This is true above all of the badly burned.' . . . There were several of the 'napalmed.' An old man, whose torso and arms disappeared under heavy bandages. A young girl with her face frightfully swollen and bespattered with burns. A little chap, 12 years perhaps, who was finishing his convalescence in a wheelchair; at the end of his legs there were only some sort of fearful reddish stumps, all that remained of his poor feet destroyed by napalm."<sup>29</sup>

On the other hand, a medical consultant for the *New York Times*, Dr. Howard A. Rusk of New York University College of Medicine did not find many napalm victims in South Vietnam. In a March 1967 tour of twenty civilian hospitals from the 17th parallel to the Gulf of Siam he did not see a single napalm burn and only two due to phosphorus shells. Rusk concluded that only 15% of admissions were for war casualties, the remaining 85% being accidents and disease. For every burn inflicted by war,

<sup>27</sup>*Chronicle*, February 9, 1965.

<sup>28</sup>Frank Harvey, *Air War Vietnam*, New York: Bantam Books, 1967. See also John Duffett, (ed.), *op. cit.*

<sup>29</sup>*Le Monde*, March 12, 1966.

he attributed scores to inexperience in handling pilfered gasoline. In another article, Rusk emphasized the lack of medical facilities and care in South Vietnam, there being only 1000 doctors in the entire country, 800 of whom are in the armed forces.<sup>30</sup> It has been pointed out that Rusk visited perhaps only 20% of the civilian hospitals in South Vietnam and that he relied too heavily upon statistics furnished by the Government of South Vietnam.<sup>31</sup>

White phosphorus is the classical ignition substance for napalm. Elementary phosphorus does not occur in nature; on exposure to air it ignites spontaneously. It has come into increasing use in Vietnam as a munition which can be delivered as either bombs or shells. The maximum allowable concentration of white phosphorus in air is 0.1 mg/cu. m.<sup>32</sup> Dr. A. Behar, a French physician, writes:

"Phosphorus has the particularity that inside the wound or burn, it burns slowly. On occasion this slow combustion lasts up to 15 days. At night can be seen the greenish light produced by the material that continues burning the flesh and bones. Besides this, accompanied by the wounds and the profound burns, the victims suffer a severe intoxication produced by the augmentation by three or more times the quantity of inorganic phosphorus in the body."<sup>33</sup>

According to a manual on civilian defense: "One thing to remember about these phosphorus bombs is to be sure that the solid particles that are in the air do not touch your skin. They cause terrible burns. . . ."<sup>34</sup>

Evidently, this weapon is being directed at human targets: "We killed them one by one with grenades, direct hits with Willie Peter—white phosphorus artillery shells—or with napalm," said Major John Borgman of Aurora, Ind.,<sup>35</sup> Commander of the Special Forces' Fifth Mobile Strike Force.

#### ANTI-PERSONNEL GASES

The three gases admitted as being deployed in Vietnam are described variously as "irritant," "harassing," "riot control," "tear" or "anti-personnel" gases. The designation "tear gases" is definitely not correct since only CN and CS are lachrymatory; DM, in fact, is without detectable odor. Similarly, adjectives such as "irritant" and "harassing" may imply that these gases cannot be toxic and/or lethal, which is certainly not the case.

CN is the "classical" tear gas used for many decades for riot control. CS is so-called "super" tear gas; it was developed at the CBW establishment

<sup>30</sup>*New York Times*, March 12, and April 9, 1967.

<sup>31</sup>R. R. Holt, Research Center for Mental Health, letter to the *New York Times*, April 9, 1967.

<sup>32</sup>*Merch Index*, Vol. 7, (1960), p. 810.

<sup>33</sup>Personal communication from Dr. A. Behar, a French physician who visited North Vietnam in January 1967.

<sup>34</sup>Isabelle Fairhurst, *Manual of High Explosives, Incendiaries and Poison Gases*, 1942.

<sup>35</sup>*Chronicle*, March 31, 1969.

at Porton Down in England and is covered by British Patent No. 967660, November, 1960. DM is known as "adamsite" or "vomiting gas." Army Manuals caution that DM is not to be used in situations where "deaths are unacceptable."

Field Manual 3-10<sup>36</sup> states that:

"... riot control agents used in field concentrations do not permanently injure personnel. When they are used in enclosed places, prolonged exposure to the resulting high dosages can disable personnel for several hours and result in serious physiological reactions. The following riot control agents are employed as aerosols against hostile troops or rioting personnel:

a. CS This agent irritates the eyes, nose and throat. CS is the most effective of the riot control agents, even in extremely low concentrations. Its effects on the eyes and respiratory system continue for five to ten minutes after exposure to fresh air. During that time most personnel are incapable of effective action. CS that is inhaled before masking or that is trapped in the mask while it is being put on gives the impression that the mask is leaking. This impression, coupled with such effects as chest tightness, nausea, and a burning sensation of the eyes, may cause poorly trained troops to remove their masks, thereby exposing themselves to additional concentrations of CS or of any other agent used in conjunction with CS.

b. CN This agent quickly irritates the upper respiratory passages and eyes, causing an intense flow of tears from unmasked personnel within seconds of exposure. As a secondary effect, in high concentrations CN is irritating to the skin and can cause a burning, itching sensation, especially on moist parts of the body. Some individuals experience nausea following exposure. CN is dispersed as a thermally or explosively generated aerosol or as a solution in chloroform (CNC).

c. DM This agent causes violent sneezing, nausea, and vomiting. DM1 is micropulverized DM. The physiological reaction to DM is sufficiently severe to incapacitate personnel for several hours after exposure. Since DM requires several minutes to produce maximum effects, it may be combined with CN in munitions to produce effects more rapidly. CN-DM munitions are particularly useful against violent rioters. DM alone is not approved for use in riot control dispersers in any operation where deaths are not acceptable. Excessive, and possibly lethal, or completely incapacitating dosages can be developed from its use. However, it may be used in military or paramilitary operations, in counterinsurgency operations, or in limited or general war where control of target personnel by the incapacitating effects is desired and where possible deaths are acceptable."

According to one calculation, the explosion of one British CS grenade in an average sized living room would result in a lethal dose to half the people

---

<sup>36</sup>Field Manual 3-10, *op. cit.*

in 20 minutes. Police instructions on the use of the CS state that it is "only to deal with armed criminals or violently insane persons in buildings from which they cannot be dislodged without danger of loss of life, or as a means of self-defense in a desperate situation, and that in no circumstances should they be used to assist in the control of disturbances."<sup>37</sup>

Army tests of CS gas showed this agent may cause severe skin blistering that requires hospitalization and may lead to serious infections. The tests were completed in June, 1966, and the results were released this spring at the request of Rep. Emilio Q. Daddario (Dem-Conn.).<sup>38</sup>

Whatever the manner of application of the anti-personnel gases upon their introduction in the Vietnam war, it is certain that by the end of 1965 it had become a common practice to use them in underground spaces. An air pump called a "Mighty Mite" was adapted for pumping the gases underground. In one incident, widely reported in the international press, an Australian soldier was killed by smoke and gas in a tunnel even though he was wearing a mask.

At the present time there is no accurate means of estimating the number of deaths arising from the use of CN, CS and DM. The fragmentary reports which are available suggest that the number of fatalities must be substantial. Thus, a Canadian M.D. who spent several years at the Quang Ngai hospital in South Vietnam writes:

"During the last three years I have examined and treated a number of patients, men, women and children, who have been exposed to a type of war gas, the name of which I do not know. The type of gas used makes one quite sick when one touches the patient, or inhales the breath from their lungs. After contact with them for more than three minutes, one has to leave the room in order not to get ill.

The patient usually gives a history of having been hiding in a cave or tunnel or bunker or shelter into which a canister of gas was thrown in order to force them to leave their hiding place. Those patients that have come to my attention were very ill with signs and symptoms of gas poisoning similar to those that I have seen in veterans from the First World War treated at Queen Mary Veterans Hospital in Montreal. The only difference between the cases was that these Vietnamese patients were more acutely ill and, when getting over their acute stage, presented a similar picture to that of the war veterans.

Patients are feverish, semi-comatose, severely short of breath, vomit, are restless and irritable. Most of their physical signs are in the respiratory and circulatory systems . . .

The mortality rate in adults is about 10%, while the mortality rate in children is about 90% . . ."<sup>39</sup>

<sup>37</sup>I. Brownlie, *op. cit.*, p. 117.

<sup>38</sup>*Chronicle*, June 28, 1969. A technical report is available from the Department of Commerce, Clearing House for Scientific and Technical Information, Port Royal Road, Springfield, Virginia, at \$3.00 per copy.

<sup>39</sup>Private communication to E. W. Pfeiffer.

An article in the *Saigon Post* (October 11, 1967) titled "U.S. Tear Gas Use Saves Lives of Viet Innocents" provoked this response from an eye-witness:

"About three and one-half months ago, I was involved in an attempt to be of assistance to some six thousand new refugees that had been created in Quang Ngai Province by a forced evacuation of an area under Viet Cong control. . . . I took two of them, a ten-year old boy and a twelve-year old girl, by far the most seriously ill, and drove the eight miles back to Quang Ngai. Emergency measures proved fatal for the boy; he was in the morgue the next morning when I went to the hospital: he died from an overdose of tear gas. . . . The victims reported that about twenty women and children did not even make it out of the cave . . ."<sup>40</sup>

There have been unconfirmed reports that agent BZ, an "incap," has been released in Vietnam;<sup>41</sup> so far as the writer is aware, these reports have never been documented and verified.

Chemical agents are disseminated by either bursting-type munitions or spray devices. A dispenser attached to compressed air tanks mounted on a helicopter or vehicle can disperse about 50 lbs. of micropulverized CS in approximately two minutes. A helicopter flying at 44 knots can disseminate an effective concentration over a frontage varying from 1500 to 2500 meters and, in a wind speed of about 15 knots, the effective downwind coverage can be about 500 meters. A portable dispenser can disseminate about 8 lbs. of agent in 19 seconds. In a wind of 5 knots, an effective concentration is maintained in an area 15 to 25 meters wide and 200 meters downwind. In the same wind speed, a burning-type grenade covers an area 5 meters wide by 25 meters downwind; the bursting-type grenade covers an area 10 meters wide by 25 meters downwind.

The Defense Department explained in early 1966 that a new Vietnam battle tactic was to flush enemy troops out of bunkers and tunnels, prior to a B-52 attack, with a helicopter-borne blanket of (CS) gas.<sup>42</sup> Jay Orear, Chairman of the Federation of American Scientists, asked, "Isn't such usage lethal in purpose and thereby contrary to the objectives of the 1925 Geneva Protocol?"<sup>43</sup>

<sup>40</sup>David Neufeld, letter to *Saigon Post*, October 20, 1967.

<sup>41</sup>M. F. Kahn and E. Langer, in J. Brownlie, *op. cit.*, pp. 91 and 127.

<sup>42</sup>*New York Times*, February 22, 1966. The amount of CS gas requisitioned by the U.S. Army for Vietnam has escalated from 367,000 lbs. in 1964 to 6,063,000 lbs. in 1969. These figures, which are from the *Congressional Record*, H4775, do not indicate if agencies other than the U.S. Army procure additional amounts of CS. According to several press reports this gas, and perhaps CN, are in routine military use in Vietnam. *Chronicle*, September 29, 1969; *New York Times*, December 6, 1969.

<sup>43</sup>See *Federation of American Scientists Newsletter*, 20:5 (May 1967), *op. cit.*

All chemical agents are packed in gray containers with an appropriate number of bands, in various colors, to indicate the filling. Riot control and incapacitating agents are marked with red bands, one band for non-persistent effect agents and two bands for persistent effect agents. The presence of a low explosive charge is indicated by an additional brown band. Field Manual 3-10 states:

"The decision to employ lethal or incapacitating chemical or biological agents is a matter of national policy. When the decision is made, United States Army, Navy, Air Force and Marine Corps commanders will receive through command channels the authority to use such agents and specific guidance in their use. General policy guidance is contained in Armed Forces Doctrine for Chemical and Biological Weapons Employment and Defense (FM 101-40, NWP 36(C), AFM 355-2, and LFM 03), 19 April, 1964."

However, President Johnson does not appear to have been consulted on the first use of gas in Vietnam.<sup>44</sup>

#### HERBICIDES

The possibility of using herbicides in military operations was considered seriously in World War II. The U.S. Army had, by the end of that war, tested more than 1000 different chemicals at Fort Detrick in Maryland. By June 1945, the Army was prepared to recommend the use of ammonium thiocyanate as a defoliant in the Pacific theatre. The plan was never executed, however, because civilian authorities feared the charge of using "poison gas warfare."

In Vietnam preliminary tests were carried out between July 1961 and April 1962, with the esters of 2,4-D and 2,4,5-T.<sup>45</sup> Additional tests in Thailand indicated that these herbicides would kill most of the vegetation of the area. Highway 15 out of Bien Hao was sprayed along a seventy-mile stretch in early 1962. A high official of the Saigon Government stated: "Tests have shown that manioc and sweet potatoes die four days after having been sprayed. These are the two most important food staples for the communist bands in the mountains." The first flight of C-123 cargo planes, equipped with spray nozzles and tanks, arrived at Tan Son Nhut airport on November 29, 1961, to launch the vast operation which was to become known as "Ranch Hand."

---

<sup>44</sup>See *In the Name of America*, Clergy and Laymen Concerned about Vietnam, Turnpike Press, 1968, p. 117.

<sup>45</sup>The n-butyl ester of 2, 4, 5-T was used extensively by the British as a defoliant in the political and military emergency in Malaya in the 1950's. According to D. J. Osborne, *Nature* Vol. 219 (1963) p. 564: "On a much larger scale the methods employed in Malaya are now used in Vietnam."

TABLE 1  
Estimated Areas Treated with Herbicides in South Vietnam<sup>46</sup>

Year	Acres/year		Total
	Defoliation	Crop Destruction	
1962	17,119	717	17,836
1963	34,517	297	34,814
1964	53,873	10,136	64,009
1965	94,726	49,637	144,363
1966	775,894	112,678	888,572
1967 (Jan-Sept)	843,606	121,400	965,006
1967 (Total)	1,486,446	221,312	1,707,758
1968	1,297,244	87,064	1,384,308
1969 (Jan-Mar)	356,421	4,693	361,114

Table 1 shows that a considerable portion, about 10%, of the area treated is crop land. It has been argued that the destruction of food reserves in Vietnam, by defoliation and other means, afflicts chiefly the aged, the infirm, pregnant and lactating women, and children under five years of age.<sup>47</sup> The use of starvation as a weapon has not been very effective militarily inasmuch as soldiers can generally forage for themselves at the expense of the civilian population.

Although much remains to be done by way of studies, a substantial amount of information has been compiled in the last two years on the defoliation of Vietnam. The Pentagon commissioned a literature review by the Midwest Research Institute in 1967. In the following year Dr. Fred Tschirley of the Department of Agriculture, at the request of the State Department, made an air inspection of the forest areas that had been sprayed.<sup>48</sup> Finally, in March of 1969, Drs. E. W. Pfeiffer and G. Orians carried out a survey in South Vietnam under the joint auspices of the Society for Social Responsibility in Science and McGraw-Hill Publications.<sup>49</sup> These eye-witness observations, plus the valuable reviews of Galston, furnish the background for much of the data reported in the present paper.

Table II provides information on the main types of herbicides employed. Orange and purple are used interchangeably and the former is favored over

<sup>46</sup>These data were compiled from the Midwest Research Institute Report, *op. cit.*; *Guardian*, May 3, 1969; and Richard D. McCarthy, *The Ultimate Folly*, New York: Vintage Books, 1969, p. 79.

<sup>47</sup>Jean Mayer, *Scientist and Citizen*, 9:7 (1967). See also San Francisco *Examiner* and *Chronicle*, July 14, 1968.

<sup>48</sup>Dr. Tschirley's report appeared in *Science*, Vol. 163, (February 21, 1969), p. 779.

<sup>49</sup>See the two-part report in *Scientific Research*, June 9, 1969, p. 22, and June 23, 1969, p. 26.

TABLE II  
Herbicides Sprayed in Vietnam<sup>50</sup>

Agent	Composition	% of Total	Use
Orange	n-butyl esters of 2,4-D and 2,4,5-T	50	General defoliation of cover and crops
Purple	n-butyl esters of 2,4-D and 2,4,5-T, plus some isobutyl esters of 2,4,5-T		General defoliation of cover and crops
White	Triisopropanolamine salts of 2,4-D and picloram (Tordon)	35	Persistent defoliation
Blue	Cacodylic acid	15	Rice and grasses

all herbicides because of its general utility and low cost. Figures released in 1968 suggested \$12.5, \$33.8, and \$45.9 million as the sums for herbicide spending in fiscal 1966, 1967, and 1968, respectively, while the estimated expenditure for the year starting July 1, 1968, was set at \$70.8 million.<sup>51</sup>

The phenoxyacetic acids are considered not highly toxic to animal life<sup>52</sup> and they leave no residue in the soil. Obviously, the toxicity of 2, 4-D and 2, 4, 5-T has been seriously underestimated. Bryce Nelson reported in the Fall of 1969 that one of the main herbicides used in Vietnam, 2, 4, 5-T, would be restricted in its domestic uses as of January 1, 1970, because of its potential teratogenic effect. The action against the herbicide came from the White House after the Bionetics Research Laboratories, Inc., reported to the National Cancer Institute that the offspring of laboratory animals fed 2, 4, 5-T showed 100% birth defects. The other phenoxyacetic acid, 2, 4-D, was said to "require further study." Almost immediately it was stated that the restriction would not apply to the use of 2, 4, 5-T in Vietnam.<sup>53</sup> In the Summer of 1969 several Saigon newspapers disclosed a sharp rise in the incidence of monster births and linked this phenomenon to the defoliation operation. The newspapers were ordered out of business by the Thieu government.<sup>54</sup>

The greatest threat from their massive application in Vietnam is that they may denude the land, alter the ecology (including that of the soil),<sup>55</sup> change the climate and possibly latterize the soil. These herbicides may cause levels of nitrate to accumulate in plants which render the leaves quite toxic to animals.<sup>56</sup> No precise data are available on the rate of herbicide

<sup>50</sup>*Scientific Research*, June 9, 1969, p. 27.

<sup>51</sup>*Chronicle*, July 4, and 27, 1968.

<sup>52</sup>See, however, a report on neurological damage ascribed to 2,4-D by N. P. Goldstein, et al. in *Journal of the American Medical Association*, November 7, 1959.

<sup>53</sup>*Los Angeles Times*, October 30, 1969; *New York Times*, December 7, 1969.

<sup>54</sup>*Chronicle*, December 1, 1969.

<sup>55</sup>A. Calston, *New Scientist*, June 13, 1968, p. 583.

<sup>56</sup>E. W. Pfeiffer, University of Montana, Missoula, Montana, personal communication.

application in Vietnam, but from the annual cost figures for chemicals it can be estimated that upwards of 10 million gallons are applied annually. This would mean that the dose is several gallons per acre; in any case, it is believed to be up to nine times that used for weed control within the U.S.<sup>57</sup>

Cacodylic acid contains 54.29% arsenic. The American Association for the Advancement of Science has asked that the use of this herbicide in Vietnam be discontinued.<sup>58</sup> At the present time there is no precise information on the fate of the arsenic contained in cacodylic acid. Biochemical systems are known which reduce and demethylate the arsenical, thus rendering it substantially more toxic.

Picloram, or Tordon, a product of Dow Chemical, is not authorized for application to a single American crop.<sup>59</sup> While the substance is apparently not absorbed by animals, it appears to have fantastic stability in the soil. In one experiment less than 4% of the applied dose had vanished from the test plot in 467 days. It thus remains in the soil and retains its phytotoxicity for decades.

Defoliation has been most severe along roads and waterways, around base camps and in the vicinity of Saigon. Around the latter city, agent White is preferred since it is dissolved in a water vehicle and the spray is less susceptible to drift. Demands for missions are such that a priority must be assigned and it seems that only lack of equipment has prevented the defoliation of the entire country. Even the vegetable plots of the experiment station at the College of Agriculture of the University of Saigon have been sprayed with herbicides. The most severely treated area is the estuary of the Saigon River—the Rung Sat—which once was rich in mangroves. About 25% of the forest area defoliated has been sprayed more than once. Most of the acreage treated is within War Zones C and D; spraying in the Delta is denied although this point is controversial.

Defoliation has also been carried out in Thailand<sup>60</sup> and Cambodia. The State Department recently reported that Cambodia has lodged a \$8.7 million claim for a defoliation “accident” alleged to have occurred in April of this year. The claim was broken down into \$7.6 million for loss of rubber trees, \$228,000 for destruction of fruit trees, and \$857,000 for lost earnings of workers. A team of U.S. scientists visited Cambodia in the summer of 1969 to survey the damage and investigate the claim.<sup>61</sup>

The Army of the Republic of Vietnam initiates a defoliation mission through an order, ultimately cleared through the U.S. Ambassador in Saigon, and the operation is performed by the U.S. Air Force under Ranch Hand. Preferred conditions for defoliation flights are temperatures below 85° and a wind speed less than 10 knots. To observe the best contrast between treated

<sup>57</sup>*loc. cit.*

<sup>58</sup>See discussion in *Science*, Vol. 161 (July 19, 1968), p. 253.

<sup>59</sup>C. R. Harvey and J. D. Mann, in *Scientist and Citizen*, September, 1968, p. 166.

<sup>60</sup>*Hard Times*, No. 37, June 23-30, 1969.

<sup>61</sup>*Chemical and Engineering News*, July 7, 1969, p. 27.

and non-treated areas, inspections should be carried out in the wet season.

It is generally agreed that one defoliant application will destroy mangrove associations for decades. In forest areas a single spray will give a modest kill of trees; two applications may kill 50% of all woody plants. Bamboo tends to invade subsequent to defoliation. Rubber trees, especially seedlings, are susceptible to herbicides. The entire 250-acre plantation of 33-year old rubber trees at Ben Cui was destroyed in one accidental spraying in 1965.

In their tour of defoliated areas of South Vietnam, Pfeiffer and Orians saw not a single insectivorous or frugivorous bird except for barn swallows, which they took to be migrants from the north. Few fish-eating birds were sighted and, according to these observers, future studies of the animal ecology of South Vietnam should be focused on the mangrove swamps and should include examination of the status of crustaceans and mollusks. The endangered species are considered to be the Douc Langur and the Indochinese Gibbon. The area is also home of the world's rarest species of bovine such as the Kouprey, Banteng and Gaur. Large numbers of deer, tiger, elephant and rhinoceros have been driven over into Cambodia because of the general havoc in the war-torn jungle.<sup>62</sup>

Operation Ranch Hand has had an adverse effect upon the economy of South Vietnam. In one year rubber production fell by 30%. Officials of the Rubber Research Institute fear that rubber culture in South Vietnam may be at an end. Dead trees may be harvested for lumber up to one year or so after death; however, much of this wood is laden with shrapnel. Jack fruit, mango, manioc and guava have similarly fallen victim to herbicides. Civilians have not been very successful in securing compensation for these losses.<sup>63</sup>

#### AMERICAN REACTION

Chemical warfare in Vietnam has received criticism from two quarters, namely, the science community and the Congress. The first organized opposition came in early 1966 via a statement issued by 29 prominent scientists living in the New England area.<sup>64</sup> The statement called on the President to repudiate the use of chemical weapons in Vietnam and labelled such action "barbarous" in that it represents "an attack on the entire population." The spokesman for this group was Dr. John T. Edsall of Harvard University. Problems arising from the military use of herbicides was the subject of a petition from twelve plant physiologists to the President in September, 1966.<sup>65</sup> Later in the same year Edsall and Matthew Meselson, also of Harvard, circulated among professional scientists a "Presidential Letter"

---

<sup>62</sup>J. I. Craighead, Montana Cooperative Wildlife Research Unit, letter dated June 13, 1969, to General Charles A. Lindbergh, World Wildlife Fund, New York.

<sup>63</sup>*Scientific Research*, June 9 and 23, 1969.

<sup>64</sup>*Chemical and Engineering News*, January 24, 1966, p. 26.

<sup>65</sup>A. Galston, *op. cit.*, p. 73.

(petition). Signatures were requested by October 31, 1966, but the petition, bearing 5000 names, was not filed until February 14, 1967.<sup>66</sup> The statement again called for an end to "anti-personnel and anti-crop chemical weapons in Vietnam" and suggested a policy review of CBW with a declaration of intention to return to the Roosevelt position maintained in World War II.

Meanwhile, in 1966 Dr. E. W. Pfeiffer of the University of Montana had introduced a resolution at the spring meeting of the Pacific Division of the American Association for the Advancement of Science (AAAS) which demanded a study, by experts, of the chemical warfare program in Vietnam.<sup>67</sup> Subsequently, the resolution was "watered down" to include a general study of the effect of environmental intrusions, reference to Vietnam was deleted, and the measure adopted at the December 30, 1966 meeting of the AAAS. A committee of the AAAS, chaired by Rene Dubos, grappled with the question for a year and ultimately referred the problem of Vietnam to the Defense Department.

The latter then commissioned the study—which proved to be purely a review of the literature without any field work whatsoever in Vietnam—by the Midwest Research Institute. Although the report was not made available to the public until after the December 1967 meeting of the AAAS, the Director of Defense Research and Engineering, John S. Foster Jr., gave assurances that "... qualified scientists ... have judged that seriously adverse consequences will not occur. . . ."<sup>68</sup> A new AAAS committee, headed by Dr. David R. Goddard, was set up to examine both the MRI report and a review of that report to be prepared by an ad hoc committee of the National Academy of Sciences—National Research Council (NAS-NRC).<sup>69</sup> Although two of the four appointees to this committee promptly resigned, by July of 1968 a majority of the Board of the AAAS released a report urging a field study in Vietnam by the United Nations; the same statement requested an end to the use of arsenical herbicides.<sup>70</sup>

The NAS-NRC committee, headed by Dr. A. Geoffrey Norman, former Division Chief at the Army Chemical Corps Biological Laboratories, Ft. Detrick, Md., completed its study of the MRI Report and concluded that further information was required on ecological changes arising from intensive use of herbicides. Earlier in 1968, at the request of the State Department, Dr. Fred Tschirley of the Crops Protection Research Branch, USDA, Beltsville, Md., had spent the period from mid-March to mid-April in Viet-

---

<sup>66</sup>See *Federation of American Scientists Newsletter*, 20:5 (May 1967), *op. cit.*

<sup>67</sup>E. W. Pfeiffer, *Scientific World*, No. 6, 1968, p. 16; *Science Journal*, February, 1969, p. 33.

<sup>68</sup>A. Galston, *op. cit.*, p. 73.

<sup>69</sup>A history of the attempts of the AAAS to deal with the problem of Chemical Warfare appeared in *Scientific Research*, January 22, 1968, p. 13.

<sup>70</sup>*Science*, Vol. 161, (July 19, 1968), p. 253.

nam surveying ecological effects attributable to Operation Ranch Hand. His report recommended intensive ecological research in Vietnam (after cessation of hostilities), continuing assessment of forestry and watershed values and "strip" defoliation to assure regeneration of plant and animal life.<sup>71</sup>

Pfeiffer reappeared before the Committee on Council Affairs at the 1968 meeting of the AAAS in Dallas to request support for the position adopted by the Board in July.<sup>72</sup> At that meeting a "balanced" symposium, jointly sponsored by the AAAS Committee on Science in the Promotion of Human Welfare and the Scientist's Institute for Public Information, reviewed possible ecological consequences of the use of herbicides in Vietnam. After heated debate and elimination of the word "Vietnam," the AAAS officially supported a field study "of the potential long-term and short-term ecological risks and benefits" of the wartime use of herbicides.

Finally, at the Dallas meeting, an independent group named "Scientists' Committee on Chemical and Biological Warfare" was set up with Pfeiffer as Executive Secretary and J. B. Neilands of the University of California, Berkeley as Chairman. Other organizing members of this group included A. W. Galston of Yale, E. U. Condon of Colorado, and J. T. Edsall of Harvard. This organization has convened informational symposia in conjunction with the annual meetings of the Federation of American Societies for Experimental Biology (Atlantic City, April, 1969) and the American Society for Microbiology (Miami, May, 1969). The objectives of this group include field studies in Vietnam, public education on the general issue of CBW, and ratification of the Geneva Protocol.

In the Congress one of the earliest critics of the Vietnam herbicide program was Bertram L. Podell (Dem-NY), a member of the House Committee on Science and Astronautics. In a statement issued on May 14, 1968, he said: "The use of chemicals in Vietnam is little short of barbarism." In what must now be judged a prophetic extension of these remarks he continued: "It is ironic that the plans to drop ten million gallons of vegetation and crop-killing poisons will cause a shortage of garden and weed killers. This circumstance demonstrates how dangerously free we have been using chemical and biological poisons for domestic purposes, including DDT and other pesticides, without knowing how serious their long-range impact may be." Podell said he planned to introduce a bill establishing a Presidential Commission on the Use of Chemicals. Subsequently, Congressman Donald Fraser (Dem-Minn.) asked Secretary of Defense Clark Clifford for a "full explanation" of the destruction of rice crops, and he remarked: "I question whether starvation is the type of weapon Americans want our military to employ."<sup>73</sup>

<sup>71</sup>*Ibid.*, Vol. 163 (February 21, 1969).

<sup>72</sup>For an account of the discussion on Chemical Warfare in Vietnam at the 1968 meeting of the AAAS in Dallas, see *Science*, Vol. 163 (January 3, 1969), p. 58.

<sup>73</sup>*Los Angeles Times*, August 12, 1968.

Certainly the most vigorous and persistent Congressional critic has been Richard D. McCarthy (Dem-N.Y.).<sup>74</sup> Early in February of 1969, having viewed a National Broadcasting Company documentary on the subject, he decided to inform himself on CBW. On March 4, he arranged a private U.S. Army briefing for interested members of Congress. Still not satisfied, McCarthy then sent a set of policy questions to Defense Secretary Melvin Laird, Secretary of State William P. Rogers, and other departments and agencies. Several of McCarthy's questions dealt with aspects of the use of herbicides and gases in Vietnam. In replying on April 15 for the Defense Department, Foster stated that there are no herbicides used in Vietnam to destroy vegetation which have not been widely used in the U.S. for agricultural or industrial purposes. Foster also said that the Department supports the concept of a comprehensive study of the long-term effects of the limited defoliation program, and he maintained that there was no evidence "to date" of permanent damage. As regards anti-personnel gases, he claimed that CS is the only riot control agent currently employed in Vietnam, although "CN was also authorized some years ago," and that there were no known verified instances of lethality by CS. The joint reply from Secretary of State and the Arms Control and Disarmament Agency, dated April 7, claimed that herbicides are not included in the Geneva Protocol, although it was admitted that the instrument ". . . is not without ambiguity as to the range of prohibited chemical weapons."

In responding to these answers, McCarthy first complained of a contradiction between the replies and the information that is available to the public. He then placed in the Congressional Record testimony and evidence for both ecological damage and lethal (in effect) use of gas.

On April 30, 1969, Congressman Edward I. Koch (Dem-NY) joined with McCarthy in introducing H. J. Resolution 691, a bill to establish a multinational commission to examine and issue a public report on the ecological effects of the use of herbicides in Vietnam.<sup>75</sup> The five-man commission would be composed of qualified civilian scientists appointed by the U.S., the Republic of South Vietnam, and the member nations of the International Control Commission. Congressman McCarthy, joined by 23 other Representatives, proposed H. J. Resolution 457, a bill to urge the President to resubmit the Geneva Protocol for ratification. On June 17, 1969, the White House press secretary confirmed that President Nixon had recently ordered a sweeping review of the Government's policies in the area of CBW, including possible consideration of the ratification of the Geneva Protocol.<sup>76</sup> The President's November 25, 1969 renunciation of biological weapons will result in the scrapping of all agents, including those which attack plants and

<sup>74</sup>See *Congressional Record*, April 21, 1969, for the dialogue between Congressman McCarthy and the Administration.

<sup>75</sup>*Congressional Record*, April 30, 1969.

<sup>76</sup>*New York Times*, June 18, 1969.

animals. His move of the same date to resubmit the Geneva Protocol to the Senate is expected to be debated by that body in Spring 1970.

### CONCLUSION

The concept that anti-personnel gases and herbicides are exempt from the Geneva Protocol appears to be a peculiarly American interpretation. In reviewing the records of the Preparatory Commission for the Disarmament Conference meeting in 1931, McCarthy found that the British, French, Spanish, Yugoslavs and others considered tear gas and similar noxious gases, even if not lethal, to be covered by the Protocol. In replying to McCarthy's questions, the Defense and State Departments made no mention of the Protocol in their justification of the use of gas in Vietnam.

Napalm and white phosphorus, if not outlawed as chemical weapons, might well be prohibited under provisions of the Hague Convention, to which the United States is a party. Article 23 of Convention IV, Annex (Oct. 18, 1907) (a), (e) states that it is especially forbidden to employ "poison or poisoned weapons" or "arms, projectiles, or material calculated to cause unnecessary suffering."<sup>77</sup> Interestingly enough, in the development of napalm Fieser states that ". . . the entire thinking was for use of this material for burning down enemy targets such as munition dumps, factories, warehouses, etc."<sup>78</sup> An international symposium on napalm was published in Swedish in 1967 and subsequently translated into several European languages, with the exception of English.<sup>79</sup> Obviously, there is a need for a complete medical, scientific, and legal review of the consequences of the use of napalm and white phosphorus.

At Nuremberg the Allies defined as a very serious war crime the destruction of civilian food supplies as practiced by the German High Commissioner in Holland, Seyss-Inquart, who was responsible for the opening of dikes and the flooding of about 0.5 million acres of agricultural land. The destruction of rice and other food staples in Vietnam, while of dubious military value, is certain to increase the misery and suffering of the civilian population, and is prohibited under the Hague Convention just cited.

As regards the effect of Operation Ranch Hand on the ecology, the feeling in the general scientific community is one of seething hostility and, as such, it contrasts sharply with the behavior of official bodies, such as the professional science societies. Thus, 96 ecologists in Japan issued a statement denouncing the defoliation of Vietnam. The point of view of the individual ecologist was eloquently stated in a letter published in *Science*:

"Neither a team of experts nor 1500 references are required to assess the effects of 2,4-D, 2,4,5-T, picloram, and cacodylic acid on the vegetation of Vietnam ("Defense issues summary of defoliation study," Feb.

<sup>77</sup>*In the Name of America, op. cit.*

<sup>78</sup>L. F. Fieser, letter dated September 29, 1966, to J. B. Neilands.

<sup>79</sup>John Takman, (ed.), *Napalm, An International Symposium*, Stockholm: Rabén and Sjögren, 1967.

9, p. 613). One needs only to read the cautionary labels our government requires for these products when they are sold in the United States or note the dead vegetation and the relative absence of birds and insect life along railroads or powerline rights-of-way after these areas are freshly sprayed with such chemicals.

The Department of Defense may label 2,4-D and 2,4,5-T with the honeycoated word "defoliant," but foresters call them tree killers; farmers call them weed killers; and manufacturers call them herbicides and silvicides. Doses over 3 pounds per acre (3.36 kilos per hectare) of the standard mixture of 2,4-D and 2,4,5-T are nonselective—they kill all the foliage and twigs they contact, and when applied as oil basal sprays they kill the vegetation from the ground up. Many species of plants other than tomatoes, cotton, and tobacco are killed by the vapors of these chemicals. American foresters, farmers, highway and power companies who are careless with these compounds have often been forced to pay for crops they did not mean to kill.

The DOD can raise the red herring of "long-term" effects, but there can be no doubt about the short-term effects: 2,4-D and 2,4,5-T kill the green vegetation. When followed by fire bombs, the dead foliage and twigs burn, as they did on some 100,000 acres (about 40,000 hectares) in the "Iron Triangle" last spring.

Through the simple process of starvation, a land without green foliage will quickly become a land without insects, without birds, without animal life of any form. News photographs and on-the-spot descriptions indicate that some areas have been sprayed repeatedly to assure a complete kill of the vegetation. There can be no doubt that the DOD is, in the short run, going beyond mere genocide to biocide. It commandeered the entire U.S. production of 2,4,5-T for 1967 and 1968 [some 13 to 14 million pounds (6.36 million kilos) according to U.S. Tariff Commission reports]. If one combines this with the other chemicals the DOD concedes it is using, there is a sufficient amount to kill 97 percent of the aboveground vegetation on over 10 million acres of land (about 4 million hectares)—an area so big that it would require over 60 years for a man to walk on each acre.

The long-term effects of spraying such an area may be imponderable, but the short-term effects of using these chemicals are certain: a lot of leaves, trees, rice plants, and other vegetation are dead or dying; and a lot of insects, birds, animals, and a few humans have either migrated or died of starvation. The North Vietnamese are fortunate—they have only bombs to contend with."<sup>80</sup>

Perry's conclusions were borne out by the eyewitness accounts of the two American zoologists, Pfeiffer and Orians, who visited South Vietnam in March 1969.<sup>81</sup> Even the report of the Midwest Research Institute, prepared at the behest of the Defense Department gave no assurances that the ecology and quality of the environment would not be adversely affected by Ranch

<sup>80</sup>Thomas O. Perry, Harvard University Forest, in letter to *Science*, Vol. 160 (May 10, 1968), p. 601.

<sup>81</sup>*Science*, Vol. 163 (January 3, 1969).

Hand. While the Department used this report to justify continuation of the herbicide program, one expert (who served as a consultant) said the study was put together in 60 days by people who do not understand herbicides. Referring to this report, Tschirley is on record as saying:

Reading the MRI Report before visiting Vietnam left me with the feeling of having read a literature review that resulted in accurate general conclusions, but told me nothing about the ecological consequences of using herbicides in Vietnam. In summary, the MRI Report is a literature review of a subject for which there is a great deal of literature relating to temperate zones, but little relating to tropical vegetation. The MRI Report is disappointing because its direct application to Vietnam is so tenuous.<sup>82</sup>

Within the professional science organizations, only the AAAS has shown any concern about the defoliation of Vietnam and this has required constant prodding from Pfeiffer. Perhaps most distressing of all has been the inability of the AAAS to follow through with any kind of action program. First they threw the problem to the Defense Department, then they attempted to hand it to the United Nations (which took no action), and lately they have declared in favor of a field survey; there is no indication, however, that the latter will materialize until after cessation of hostilities.<sup>83</sup> The multi-national commission proposed by Koch and McCarthy is a step in the right direction, even though the International Control Commission is held in low repute in Southeast Asia. American scientists have both a unique opportunity and a clear responsibility to engage themselves in the problem of chemical warfare in Vietnam. This role can best be fulfilled through the educational process via preparation of scholarly studies and reports, all of which, hopefully, will serve as the basis for future public policy. The political outcome of the Vietnam struggle remains in doubt. But while the U.S. military has not yet achieved a victory on the battlefield, they have scored a major breakthrough in the introduction of chemical weapons. Since this is certain to weaken the restraints against this particular form of warfare, it is essential that the topic be opened up for public discussion.<sup>84</sup>

---

<sup>82</sup>*Congressional Record*, April 21, 1969.

<sup>83</sup>At the annual meeting in December 1969, in Boston, a resolution introduced by the Scientists' Committee on Chemical and Biological Warfare was adopted by the AAAS. The resolution asked the DOD to "immediately cease all use of 2,4-D and 2,4,5-T in Vietnam" and reiterated the need for a field study. The AAAS budgeted up to \$50,000 for a field investigation to be carried out by a Herbicide Assessment Commission, the latter chaired by Matthew S. Meselson and directed by Arthur H. Westing.

<sup>84</sup>The single most important source of background information for such a discussion is the 513 page report of hearings held before the Subcommittee on National Security Policy and Scientific Developments of the House Committee on Foreign Affairs, 91st Congress, November and December, 1969.

---

J. B. NEILANDS is a Professor of Biochemistry at the University of California, Berkeley and Chairman of the Scientists' Committee on Chemical and Biological Warfare.