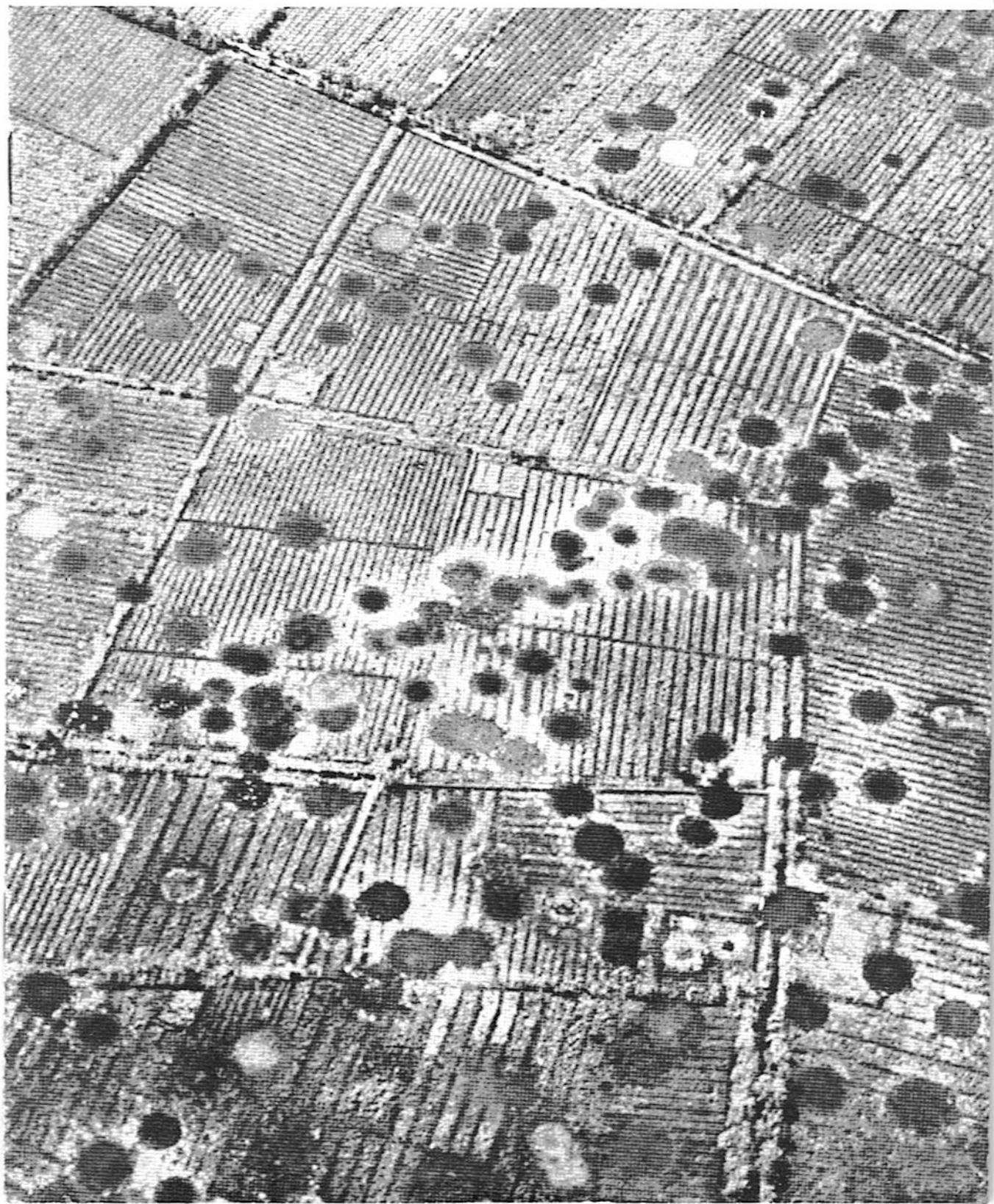


*A LEGACY OF OUR PRESENCE*

# The Destruction of Indochina

STANFORD BIOLOGY STUDY GROUP



*Cover: Bomb craters now occupy at least 100,000 acres of South Vietnam. These are manioc fields 20 miles northwest of Saigon. (Photo by E.W. Pfeiffer.)*

*Opposite: U.S. Air Force C-123's spray herbicides over cultivated Vietnamese fields as part of the massive program of environmental destruction. (Wide World photo.)*

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*A LEGACY OF OUR PRESENCE*  
The Destruction of Indochina



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The Stanford Biology Study Group is an *ad hoc* organization of some members of The Department of Biological Sciences at Stanford University. It is not an official organization of either the Department or the University. The use of titles is for purposes of identification only.

## FOREWORD

At Stanford, as at other American universities, the spring of 1970 was a time of redirected effort. In the Department of Biological Sciences, a group of students, fellows and faculty members were able to relate their own scientific training directly to the biological problems caused by the Indo-China war. This pamphlet on the ecological effects of that conflict is the result.

It has come out of the labors of a number of Stanford biologists of diverse backgrounds, working as a loosely organized committee. The group included Howard Edenberg, a graduate student in molecular biophysics; Patrice Morrow and Bruce Bartholomew, graduate students studying physiological ecology of plants; Lawrence Gilbert and Edward Merrell, graduate students in population biology and ecology; Peter Cohen, post-doctoral fellow in molecular genetics; Matthews Bradley, graduate student in developmental biology; and Patricia Caldarola and Paul Grobstein, graduate students in neurophysiology. Professor Colin Pittendrigh and I helped, also. The process of creation was at once gratifying and disturbing. We learned from one another about new things: the ecologists, three of whom have had field experience in the tropics, taught the others about the special qualities of tropical soils and ecosystems; the molecular and cellular biologists in turn looked more critically at the biochemistry of herbicides and the interpretation of the results of bio-assays.

Even in an academic setting where shared intellectual experiences are supposed to happen all the time, this one was unusual. It would have been unambiguously pleasant—were it not for the subject matter. No one can conclude, after looking carefully at the impact of our military strategy in southeast Asia, that we are fighting a war against an army. Instead, we are waging a war against a people and the land they live on. The enormity of our attack upon the Vietnamese environment has, for me, changed entirely the logic with which one evaluates the morality and even the efficacy of our operation there. After reading this report, I hope you will agree that the central question is now a simple one, "How can we claim to be acting on behalf of people when our action itself is prohibiting a future for them?"

DONALD KENNEDY,  
professor and chairman  
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Stanford University



THE WAR in Southeast Asia has gone on for more than 30 years, and during this period, the people of that area have been subjected to intense deprivation and suffering. In the last decade the United States, in its advisory and fighting roles, has not only greatly increased the immediate suffering, it has added a new and terrible dimension to warfare: as a result of strategy used deliberately to destroy the forest cover and enemy food crops and of other programs as well, we are producing devastating, long-term ecological damage. Long after first-hand memories of the war's horrors have faded, a crippled land will remain the legacy of our presence. This report attempts to evaluate the extent and the seriousness of this destruction.

In making this evaluation, it must be recognized that ignorance of tropical ecosystems is even greater than that of temperate-zone systems. However, ignorance must not be used as a license to plunder. In fact, lack of knowledge is rather a reason for caution with policies that affect the environment and human life. We do know enough to state unequivocally that the actions reported here will have serious long-term consequences and that significant damage has already occurred.

United States forces are engaged in two specific programs of environmental destruction. One is the defoliation program, nicknamed Operation Ranch Hand, in which chemical substances that remove leaves (defoliants) are sprayed onto plants from the air. Trees are often killed in the process, and in this case the chemicals act as herbicides. The other program employs aerially sprayed herbicides to destroy croplands in order to deny food to soldiers and civilians in areas controlled by the National Liberation Front (NLF). These and other acts of war of the U.S. military are justified in terms of saving the lives of American and South Vietnamese troops who are fighting for the sake of the people of South Vietnam. However, in view of the permanence of the environmental damage being produced by U.S. military operations in Southeast Asia, it is impossible to identify the benefit to the people living there or to their descendants.

### *Defoliation and crop destruction*

Over five million acres, 12 percent of South Vietnam, have been sprayed with defoliating chemicals.<sup>1</sup> If used in low concentrations, these "defoliants" may indeed merely defoliate some plants. But because the application rate in Vietnam averages 13 times that recommended by the U.S. Department of Agriculture for domestic uses such

as weed killing,<sup>2</sup> the chemicals act as herbicides.

The three major herbicides used in South Vietnam are known by the names Orange, White, and Blue. Agent Orange, until recently the most widely used in Vietnam, is a mixture of 2,4-D (n-butyl-2,4-dichlorophenoxyacetate) and 2,4,5-T (n-butyl-2,3,4-trichlorophenoxyacetate); it is directed mainly against hardwood trees and other broad-leaved plants. Mangrove forest, an important plant association found along riverbanks, can be severely damaged; one application of Orange usually kills most of the trees. Areas of this kind sprayed as early as 1961 still have shown no significant recovery.<sup>3</sup>

Agent White is primarily used near populated areas because its low volatility makes it less likely to drift off the target. White is, however, soluble in water and as a result it is washed into adjacent croplands and forests by the heavy tropical rains. Picloram, a major component of White, has been called "the most active herbicide yet discovered".<sup>4</sup> It is also the most persistent and has been likened to DDT because it does not break down into biologically inactive substances.<sup>3</sup> Tropical test areas in Puerto Rico which were sprayed with White have remained essentially bare of leaves for more than two years.<sup>4</sup> Of the Picloram applied to a California test area, 80 to 96 percent was found in the soil 15 months later.<sup>3</sup> Thus the destruction caused by this herbicide will remain long after we have left Southeast Asia. The government has not licensed Picloram for use in the cultivation of a single American crop, apparently because its herbicidal activity varies with climate and soil so unpredictably that no reasonable margin of safety can be guaranteed.<sup>4</sup> Nevertheless, White with Picloram has been used for years in Vietnam.

Agent Blue is more toxic to grasses than to

Philip Noel-Baker, 1959 winner of the Nobel Peace Prize, recalled a conversation with Henri Bonnet at the Geneva Conference of 1925. Bonnet said "Oh, yes; the form of words they've got is good. It prohibits every kind of chemical or bacterial weapon that anyone could possibly devise. And it has to. Perhaps someday a criminal lunatic might invent some devilish thing that would destroy animals and crops." Noel-Baker added that "in 1925 everyone at the Conference agreed with Henri Bonnet." (See Appendix I)

Quoted in the *New York Times*,  
December 9, 1969.

broad-leaved plants and is used mainly to destroy rice crops.<sup>5</sup> Cacodylic acid, a major component of Blue, is 54 percent arsenic.<sup>3</sup> Because arsenic poisoning of humans can occur by gradual accumulation of small doses until lethal levels are reached, the use of Blue may pose a long-term danger.

Defoliation often affects non-target areas. For example, the U.S. Defense Department claims it has not deliberately defoliated rubber plantations,<sup>2</sup> yet herbicides have severely injured the rubber industry. This and other effects of the war have caused a 25 percent decrease in the per-acre yield of rubber in Vietnam between 1960 and 1967, while in nearby Malaysia the per-acre yield increased 33 percent.<sup>2</sup> The total yield of rubber in Vietnam has dropped by over 45 percent and many small plantations have been forced to close.<sup>2</sup> Cambodian plantations and farms have also been defoliated, some by deliberate overflights of U.S. spraying aircraft (initially denied by the Defense Department but later admitted by the Department of State).<sup>3</sup> About one-third of all rubber trees in production in Cambodia were damaged by defoliation in April and May of 1969, and between May and November of 1969, rubber production in these areas fell by 35 to 40 percent.<sup>6</sup> An international group of scientists studying the spraying damage estimated losses at \$12.2 million.<sup>6</sup>

The U.S. Army admits to having sprayed over 500,000 acres of South Vietnamese crops through 1969.<sup>3</sup> This represents seven percent of the total acreage under intensive cultivation. However, a 1967 report of the Agronomy section of the Japan Science Council claimed that "...anti-crop attacks have ruined 3,800,000 acres of arable land in South Vietnam. . . ."<sup>7</sup> Because of official U.S. secrecy, the true figures are not known.

The U.S. policies of direct crop destruction, forced relocation of peasant farmers to refugee camps, bombing and burning of farmland, destruction of food caches, and large Vietnamese military draft all contribute to the severely reduced agricultural production. In 1959, South Vietnam—the "Rice Bowl" of Asia—exported 246,000 tons of rice. In 1968, 850,000 tons had to be imported, over 90 percent of it from the U.S.<sup>8</sup> Other food crops have suffered as severely.<sup>3,9,10</sup> The pineapple crop was reduced by 40 percent between 1963 and 1968, a period which coincides with the early years of intensive spray operations.<sup>8</sup> Sugar cane, manioc, tomato, beans, papaya, coconut, sweet potato, figs, cassava, and mango are all sensitive to the herbicides and the various yields have decreased from ten to 40 percent.<sup>9</sup> Overall agricultural production has de-

creased by about 30 percent.<sup>8,9</sup> The crop spraying has continued since 1968 and agricultural production is still low, although reliable figures are not available.

In addition to decreased agricultural production at present, we can reasonably expect, as discussed below, long-term damage to crop and forest land due to the presence of dangerous herbicide residues in the soil; destruction of soil microorganisms necessary for fertility; death or migration of animals responsible for pollination and seed transport; overgrowth of bamboo and other pest species; and greatly increased soil destruction by laterization.

### *Starvation as a weapon of war*

The U.S. Army justifies agricultural and ecological destruction in Vietnam for three major tactical reasons: to deny food to civilians and soldiers in "Viet Cong-held areas" under the "resource denial" program; to prevent ambushes along heavily forested roads and waterways; and to aid in visual reconnaissance of NLF base camps and supply routes by eliminating the forest canopy which hides them.

The rationale behind the "resource denial" program is that the resulting starvation will sufficiently demoralize the NLF troops so that they will surrender. However, previous wars have shown that when food is in short supply, fighting troops are the first to be fed; what is left is then rationed to civilians. Among these, the most severely affected are children, the elderly, and pregnant and lactating women. During the siege of Leningrad, for example, soldiers received 800 grams or more of bread per day while civilians starved on 200 grams per day.<sup>11</sup> The NLF remains an effective fighting force, but the incidence of civilian starvation and starvation-related diseases is rising in the central highlands of Vietnam where extensive crop destruction has occurred.<sup>12</sup> This policy of deliberate starvation contravenes, in the view of many, the Nuremberg Principles which the United States helped establish and has formally accepted (see Appendix II).

The "resource denial" program also wages war against unborn Vietnamese. As a result of two years of malnutrition and starvation experienced by the Biafran people, four out of every ten children born were deformed—with small brain size as well as severe muscular and skeletal malformation.<sup>13</sup> The South Vietnamese public health ministry refuses to provide any statistics on normal and abnormal births,<sup>17</sup> so evidence indicating the extent of birth defects in Vietnamese children is

not available. We do, however, know that malnutrition is widespread in the countryside and in refugee camps, so the potential for such abnormalities certainly exists.<sup>12-14</sup>

### *Birth defects*

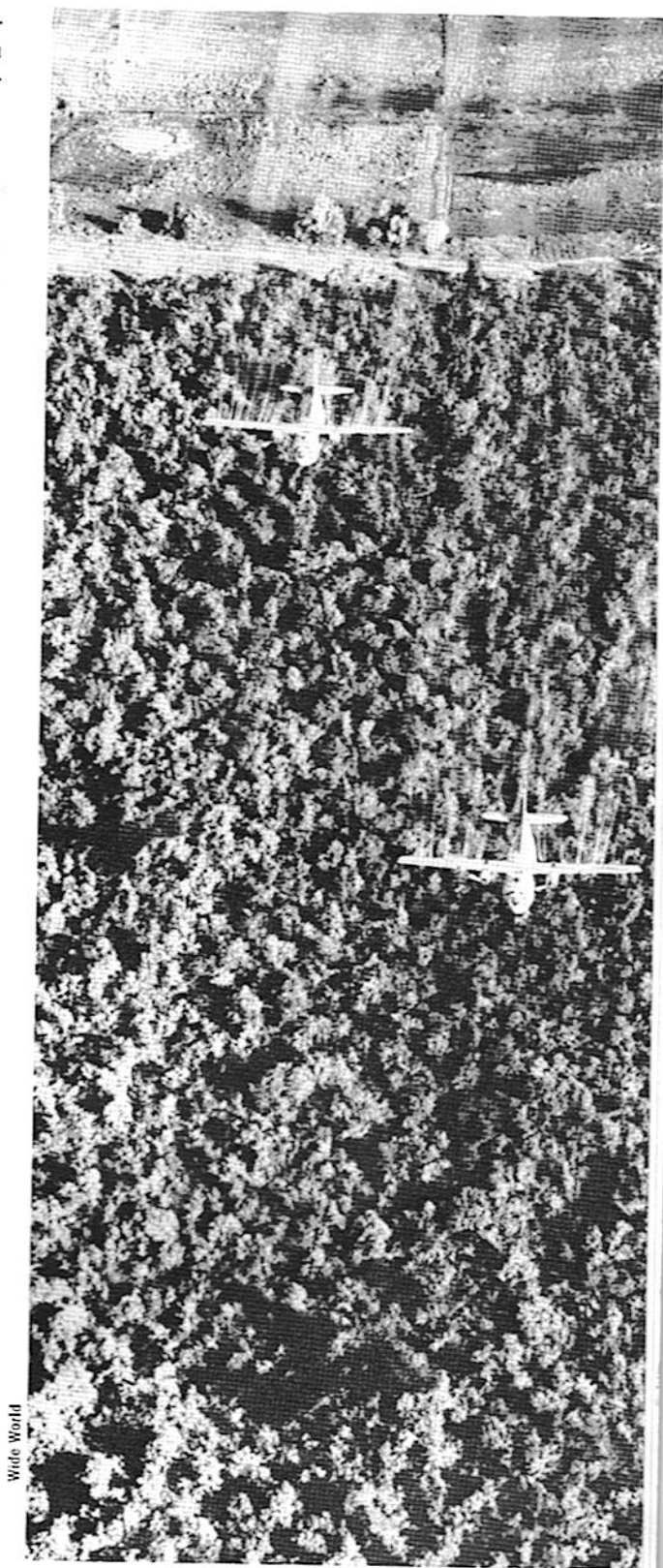
The teratogenic (fetus-deforming) effects of certain chemicals became a matter of public concern when Thalidomide was found to cause birth defects. Until 1965, 2,4,5-T (comprising 50 percent of Agent Orange) had never been tested for teratogenicity. Forty million pounds of this chemical have been sprayed in Vietnam,<sup>5</sup> without knowledge of its possible effects on man or animals. The widespread use of any chemical, without detailed knowledge of possible effects, poses grave dangers. In the case of 2,4,5-T the danger is now coming to light.

In late 1967, after two years of greatly accelerated herbicide application, Saigon newspapers began carrying front-page stories of a novel and increasingly common birth defect described as "egg-bundle-like fetus."<sup>20</sup> Some newspapers reported a rise in the incidence of deformed babies in areas that had been sprayed, and questioned whether the defoliation might be causing this. These papers were closed by the Thieu government.<sup>17</sup>

News leaks in October, 1969, forced the National Institutes of Health (NIH) to release reports demonstrating that 2,4,5-T was shown in 1965-1966 to be an exceptionally powerful teratogen. During the time the report was inexplicably suppressed by our government, millions of pounds of 2,4,5-T were used in Vietnam— and, incidentally, in the United States as well.

Producers of 2,4,5-T claimed the teratogenicity shown in these tests was due to a contaminant called "dioxin" (2,3,7,8-tetrachlorodibenzo-p-dioxin), which is found in commercial preparations of 2,4,5-T. Later studies have shown that both extremely pure 2,4,5-T and dioxin cause birth defects in the three species of experimental animals tested.<sup>18,19</sup> In hamsters, for example, commercial 2,4,5-T at dosages of 100 mg/kg (milligrams per kilogram of body weight) killed 80 percent of the fetuses and deformed many of the survivors.<sup>18</sup> In rats, only 24 mg/kg deformed about 30 percent of the fetuses (seven-fold increase in deformations).<sup>18,19</sup>

*Chemical defoliation and destruction of Vietnamese forest, jungle and agricultural areas are carried out on a vast scale. Twelve percent of the land of South Vietnam has been deluged by many millions of pounds of powerful poisons.*



Wide World



A Vietnamese woman might ingest 2,4,5-T in dosages shown to be teratogenic. Despite the absence of any actual data, one can make the following calculations based on reasonable assumptions. In an area that had been sprayed with Orange at the usual rate (27 pounds per acre), and with a one-inch rainfall after the spraying, the concentration of 2,4,5-T in the water would be 50 mg/liter.<sup>20</sup> Drinking about two liters of water a day (an average amount) would give a dosage of 100 mg/kg of 2,4,5-T each day. If the spraying plane is forced (in emergency) to rapidly empty its tanks, the dose could increase about eight-fold to 800 mg/kg. Less rainfall would also increase the dose, as would exposure to the contaminated crops or direct contact with the spray.

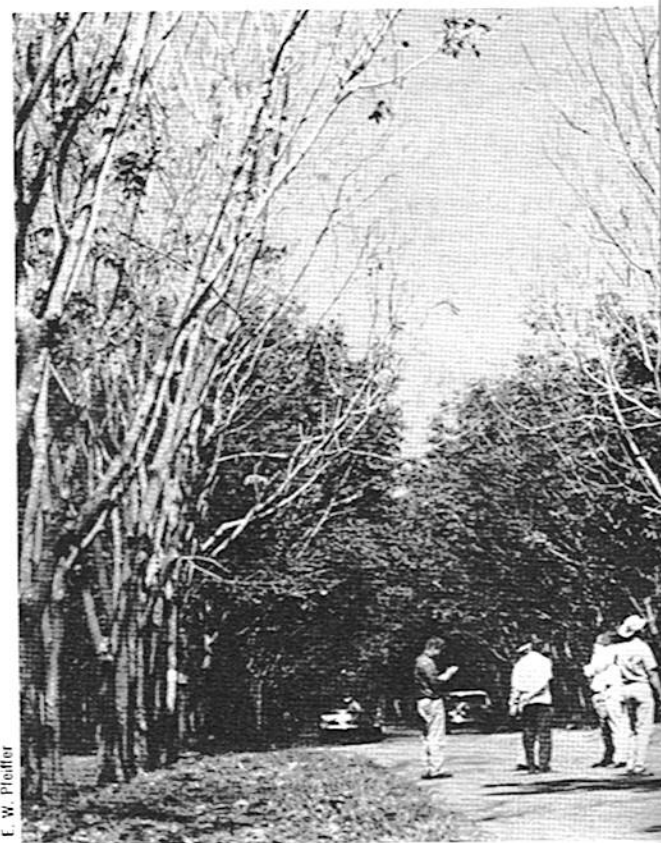
The contaminant, dioxin, is extremely dangerous by itself. It is highly toxic (0.0005-0.001 mg/kg killed 50 percent of the male guinea pigs tested) and is a cumulative poison.<sup>19</sup> It also causes birth defects; 0.009 mg/kg given to pregnant hamsters killed 82 percent of the fetuses and left 82 percent of the survivors deformed.<sup>19</sup> Since dioxin is formed when substances such as 2,4-D and 2,4,5-T are heated,<sup>18,19</sup> the combustion of timber or other material exposed to these defoliants may liberate high concentrations of dioxin into the air.<sup>19</sup> Some military men have said that the practice of using wood from defoliated areas for charcoal is a benefit to the Vietnamese. But with the possible formation of dioxin by burning, and the fact that cooking fires are predominantly tended by women, the dangers posed are obvious. Still another danger of dioxin's widespread distribution is that it may, as DDT does, concentrate in food chains.

### Bombing

Our B-52 bombing of Vietnam has changed rice paddies and forest into a lunar landscape. Each 500- to 750-pound bomb creates a crater as large as 45 feet across and 30 feet deep,<sup>2</sup> rendering this land useless for crops. We have dropped far more

*Tigers . . . seem to have benefited from the war. In the past 24 years, they have learned to associate the sound of gunfire with the presence of dead and wounded human beings in the vicinity. As a result, tigers rapidly move toward gunfire and apparently consume large numbers of battle casualties.*

From "Ecological Effects of the War in Vietnam," by Gordon H. Orians and E. W. Pfeiffer, *Science*, May, 1970.



*Rubber trees stripped of their leaves by deliberate American aerial spraying of defoliants on a Cambodian plantation. Rubber production, like food production, has been seriously crippled in Indochina.*

bombs in Vietnam than were dropped by the Allied forces in World War II.<sup>21</sup> In 1967-1968 alone, more than 3,500,000 such bombs were dropped in Vietnam.<sup>2</sup> Were these craters placed end to end, they would form a ditch 30,000 miles long—a distance greater than the circumference of the earth. The area they occupy is nearly 100,000 acres. Nor will the craters disappear with time; the jungles of New Guinea are still pockmarked from bombs dropped more than 25 years ago. Though it is theoretically possible to fill these craters, the job would involve moving more than 2.5 billion cubic yards of earth; clearly a monumental task.

Besides killing and maiming, the bombing forces many people to leave target areas or to live underground. A pediatrician recently returned from Vietnam said that as a consequence of the bombing, "People live underground day and night . . . children are suffering from a number of





disorders new to Vietnam. One is rickets, from living without sunlight."<sup>29</sup>

### *Fire and shrapnel*

Fires, some deliberately set and others touched off by artillery and bombing, are a major cause of forest destruction in Vietnam. More than 40 percent of the pine plantations and an undetermined amount of hardwood forest have been recently destroyed.<sup>2</sup>

Shrapnel is imbedded in trees, both during fighting and when the forests are strafed and bombed immediately before defoliation (to suppress possible sniper fire). Already, sawmills lose from one to three hours each day repairing saw blades damaged by shrapnel in the logs.<sup>2</sup> The economically important lumber industry will be affected by shrapnel-laden logs until these forests are regrown.

### *Social destruction*

Although this report is primarily concerned with ecological damage in Southeast Asia and the effect of this damage on the people living there, we feel that it is important to point out that other

effects of the American presence will also result in permanent damage to this part of the world. The policies of the U.S. military are destroying the Vietnamese culture and social organization. The military is transforming a basically rural agrarian society into an urban nightmare which is economically dependent on the continued presence of the U.S. America and its allies have forcibly transported people from hamlets into refugee camps located in and near cities, and have driven many more off their ancestral lands by bombing and defoliation.<sup>28</sup> Conditions in these camps are often miserable.<sup>28</sup> In the past ten years Saigon has grown from a city of 250,000<sup>2</sup> to become one of the world's largest. It now has 3,000,000 people<sup>2</sup> and is the world's most densely populated city with an average density of 148 persons per acre (Tokyo has 63 per acre).<sup>23</sup> The extremely rapid influx into the cities and surrounding camps has created massive problems in housing, feeding and providing medical care for the refugees. This "urbanization" has been caused in part by the inevitable destruction of war, but more by our policy of moving people off the land and into urban areas where they can be effectively under the control of the military.<sup>28</sup>

### *The long-term ecological effects*

Tropical forests and soils are very different from those in the temperate zone. Thus to understand the long-term effects of the war in Southeast Asia it is necessary to describe certain characteristics of tropical forests and soils.

One such feature is the intricate interdependence of the plants and animals. For instance, the trees of tropical forests depend entirely upon insects, birds, and bats (rather than wind) for pollination. Birds, bats, and ground-dwelling mammals are responsible for dispersing seeds from the parent plants to new clearings. These complex plant-animal relations have reached their greatest intricacy in tropical forests because of the mild and predictable climate. Animals can be active the year around because many flowering and fruiting trees provide food continuously. Massive defoliation means an end to this reliable

Ralph Dresser, the head of "Ranch Hand," reports that the motto of the Aerial Spray Flight of the 309th Aerial Commando Squadron is, "Only We Can Prevent Forests."

S. M. Hersh, *Chemical and Biological Warfare*, 1968.

food supply and death for those animals that are most important to the survival of the forest plants.

A second important characteristic of humid tropical forests is that most of the plant nutrients, including nitrates, phosphates, calcium, potassium, magnesium, sulphur and other elements required in smaller amounts, are tied up in the vegetation. Nutrients not contained in the vegetation itself are continuously washed from the soil by heavy rainfall. Under normal conditions, the nutrients released by decaying vegetation are rapidly recaptured and transferred to the roots of the living plants by certain fungi. But large-scale defoliation disrupts this efficient process, and the vital nutrients are quickly lost into streams. Fishing in these streams may temporarily improve because of increased aquatic plant growth due to the higher nutrient levels, but this effect is short term and is gained at the expense of soil fertility. As a direct result of lower fertility and the lack of seeds of the natural colonizing plants, pest species, such as giant bamboo, take over and spread. Once established, bamboo forms an impenetrable thicket which prevents normal forest regeneration and makes future use of the land for agriculture nearly impossible. This bamboo is very resistant to defoliants, and because it reproduces vegetatively from tough underground stems, it cannot be eliminated by burning or cutting once it is established.

From 30 to 50 percent of Vietnamese soils<sup>3,22</sup> are of a type which have the potential to turn into a brick-like substance known as laterite if they are deprived of the organic covering which protects them from exposure to severe weathering. The potential for lateritization is greatest in areas which were already disturbed before herbicide application. Cropland, as well as bombed and bulldozed areas along roadways, fall into this category. The permanence of laterite is well illustrated by the Khmer ruins around Angkor Wat in Cambodia where many of the temples were constructed primarily of this rock nearly ten centuries ago. Obviously, lateritized land is useless for agriculture.

Along lowland rivers and waterways in the tropics, rich forests grade into pure stands of mangrove trees. These plants extend stilt-roots into shallow, brackish water; the silt they trap plays an important role in delta formation. They also provide a special habitat for key stages in the life cycles of economically important fish and shellfish. The intensive defoliation program along waterways in Vietnam has killed mile upon mile of this living border. There will undoubtedly be a

drastic and long-lasting effect upon river fishing and upon the natural process of delta formation along Vietnamese rivers.

The destruction of crop and forest land fertility by herbicides, the alteration of forest composition, and the formation of laterite soil will all result in long-term damage to the agriculture and ecology of Vietnam.

### *Conclusions*

This war has two time scales. There is the immediacy of bombs and battles and of instant destruction and death, and there is the prolonged suffering and hardship which will face all survivors for generations. When the fighting has finally ended, the suffering and hardship will have only begun, for our actions in Vietnam have severely upset the environment and greatly reduced the ability of the land to support its people. The defoliation of vast areas of forest and agricultural land by poisonous and teratogenic herbicides, the saturation bombing and extensive burning, the deliberate destruction of crops with resulting starvation, malnutrition, and disease—these we have introduced to Southeast Asia and to the list of available techniques for waging war.

American troops were sent to Southeast Asia, we are told, to protect the interests of the Vietnamese people. The destruction of the Vietnamese and their environment is unfortunate, we are told, but necessary to protect the lives of American troops in wartime. Thus entwined by circular reasoning, our government claims to aid a country and its people by destroying both, and claims to protect freedom while concealing from the American public the facts about our military actions in Southeast Asia. These facts are no secret to the Asians, who experience the truth daily.

All of the military actions described in this report are continuing, and there is no reason to believe they will cease during the time that any gradual withdrawal or "Vietnamization" is attempted. Nor, under the present policy, is there any reason to doubt that during and after withdrawal we will continue to supply the Saigon regime with the tools necessary to pursue the war according to the precedents we have established. The devastation we have already caused is a monstrous legacy for those we call our friends. The environment, the social organization, the very future of Vietnam have been so severely mortgaged by action supposedly on her behalf that an American policy of immediate and permanent cessation of warfare is clearly the most effective aid we can now give.

## Appendix I

### GENEVA PROTOCOL OF 1925

The 1925 Geneva Protocol banned the use in war of all "asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices" and of "bacteriological methods of warfare."<sup>10</sup> To date, 84 states, including almost all of the major industrial powers, have ratified or acceded to the Protocol.<sup>3</sup>

The United States, however, has not ratified it.

There was general agreement at the time the Protocol was drawn that the document prohibited any and all forms of chemical or biological warfare.<sup>24</sup> This interpretation was reaffirmed by the Political Committee of the General Assembly of the United Nations on December 10, 1969; the vote, in specific opposition to United States use of herbicides and tear gases in Vietnam, was 58 yes, 3 no (United States, Australia and Portugal).<sup>25</sup>

The World Health Organization has also condemned the use of herbicides and tear gases in warfare.<sup>3</sup>

## Appendix II

### NUREMBERG PRINCIPLES

The Charter of the International Military Tribunal at Nuremberg (1945) affirmed that war crimes and crimes against humanity are crimes under international law.<sup>26</sup> The Charter defined "murder, extermination, enslavement, deportation and other inhumane acts committed against any civilian population" as "crimes against humanity," and "wanton destruction of cities, towns or villages, or devastation not justified by military necessity" as war crimes.<sup>26</sup> These principles and definitions were stated in an executive agreement concluded by the United States, the USSR, France and Great Britain on August 8, 1945. These same principles and definitions were reaffirmed by the United Nations General Assembly;<sup>27</sup> they are considered binding international law.

The United States and allied forces carry out the destruction of villages and crops, extensive bombing and defoliation, and relocation of people from the countryside to "strategic hamlets" in an attempt to deprive the NLF of potential support.<sup>28</sup> These actions—"wanton destruction," "devastation," and "deportation"—seem clearly to fall within the definition of crimes against humanity and war crimes.

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