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HERBICIDE ASSESSMENT COMMISSION OF
THE AMERICAN ASSOCIATION FOR THE
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BACKGROUND MATERIAL RELEVANT TO
PRESENTATIONS AT THE 1970
ANNUAL MEETING OF THE AAAS

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The observations and evaluations of the Herbicide Assessment Commission are those of its individual participants and should not be attributed to the AAAS or any of its component organizations.

INTRODUCTION

Over the past nine years, approximately one-seventh of the land area of South Vietnam has been treated with chemical herbicides in order to reduce vegetation and to destroy food crops in connection with military activities. This large scale application of herbicides* has occasioned concern within the scientific community that there may be serious effects on the land and people of Vietnam. Unfortunately, large areas of ignorance have prevented any satisfactory evaluation of the possible effects; of their implications for economic and health planning in Vietnam; and of their broader implications regarding the use of herbicides.

In order to obtain reliable information, the American Association for the Advancement of Science, the largest organization of scientists in the United States, has sought to encourage and participate in the conduct of a systematic on-site study of the effects of herbicides on the ecology and on human welfare in South Vietnam. As a first phase of such a study, the AAAS Board of Directors, in December 1969, commissioned the preparation of a detailed operational plan for determining " . . . the short-term and long-term consequences of the use of herbicides on the ecology of South Vietnam and on human welfare." The AAAS Herbicide Assessment Commission, the name under which this AAAS endeavor is known, began

*Herbicides are chemicals intended to kill or reduce vegetation. When they cause leaf fall, with or without killing the entire plant, they are sometimes called defoliants. We shall use the more general term, herbicides.

its work in February 1970.

Herbicides have been widely used since World War II in many parts of the world for such beneficial purposes as agricultural and aquatic weed control, forest, range, and watershed management, and the clearing of rights of way. In the United States, about 150 million pounds of synthetic organic herbicides were used in 1965 to treat approximately 140 million acres, one fourteenth of the land area of the country. However, there are serious difficulties in extrapolating this backlog of experience to the assessment of the effects of herbicides in Vietnam.

First of all, the choice of areas to be sprayed is based on very different considerations in the two cases. Domestically, herbicides are generally used to improve land values. In military applications, land values are clearly not of primary concern. For example, herbicides are used domestically to improve pine forests by selectively killing less desirable species. Militarily, the objective of spraying a forest is simply to remove as much cover as possible. Again, herbicides are used in farming to kill weeds but in war they are used to destroy food crops.

Beyond the clear difference in objectives between civil and military applications of herbicides, there are several additional factors which limit the applicability of domestic experience to the evaluation of possible effects in Vietnam. Among them are: (1) little experience with

the application of herbicides in comparable tropical ecosystems; (ii) little previous attention to the possible ecological consequences of herbicide application over a very large contiguous area; (iii) limited experience with the military rate of application, which is more than ten times higher than the average domestic rate; (iv) a meager backlog of domestic experience with two of the four herbicides that are used militarily; (v) no monitoring of the quantities of herbicides or herbicide impurities and breakdown products that may be entering the Vietnamese diet; and (vi) a need for more information regarding the possible negative medical or ecological side effects of herbicides even as they are used domestically. In this last regard, it must be remembered that although the use of herbicides is very widespread it is also quite recent, more or less paralleling and now exceeding that of chemical insecticides.

Direct examination of herbicide-treated areas in Vietnam by qualified scientists has so far been quite limited. However, an important start on the study of sprayed timber stands was made during 1967 and 1968 by the USAID Forestry Branch. On the basis of aerial observations, it was estimated that approximately nine thousand square kilometers of forest had been sprayed by mid-1967. After conducting brief ground inspections at three treated sites in early 1968, Dr. Barry Flamm, Chief of the Forestry Branch, tentatively concluded that while a single spraying causes 10 to 20 percent killing of merchantable trees, two treatments in successive years

kill 50 to 100 percent in the type of forest studied. An increase in grass cover was noted in sprayed areas and it was anticipated that bamboo also would increase. Flamm suggested further studies and recommended that forest reserves receiving two or more treatments be planned for reforestation.

During 1968 the U. S. Mission in Vietnam conducted a review of various aspects of the herbicide program. In order to obtain a preliminary assessment of ecological effects, Dr. Fred S. Tschirley of the U. S. Agricultural Research Service was asked to participate. Tschirley, a botanist, toured Vietnam from mid-April to mid-March 1968. He made aerial observations of mangrove forests and semi-deciduous upland forest areas. He also revisited the three sites established by Flamm and came to the same conclusions regarding the effects of single and multiple herbicide treatment on this forest. Tschirley also noted that mangrove species are killed by a single treatment, and estimated that sprayed mangrove forests might return to their original condition in approximately twenty years. Tschirley stressed the need for information on the successional behavior of herbicide-treated Vietnamese forests and strongly urged the initiation of long-term ecological research after the cessation of hostilities.

In March 1969 two American zoologists concerned with the ecological impact of herbicides in Vietnam, Dr. Gordon H. Orians of the University of Washington and Dr. Egbert W. Pfeiffer of the University of Montana, visited Vietnam for two weeks. They made aerial observations

of sprayed upland forests and also inspected a mangrove area by motor launch. They found no evidence of recolonization along the shore line and reported a near absence of fructivorous and insectivorous birds in the sprayed areas. They too, strongly recommended a major research effort, to be conducted jointly with Vietnamese scientists.

Following the establishment of the AAAS Commission, our work was conducted in several stages including a trip to Vietnam in August and September 1970. We inspected several types of herbicide-treated areas in order to acquire information upon which more extensive studies could be based. Our observations extended into several areas not previously studied and, in certain instances, significantly differed with prior reports.

Previously, the Commission conducted a survey of the relevant literature. At the same time, numerous experts and officials in various fields were consulted for information and advice. A list of questions for possible study was drawn up and circulated for comment to over 200 individuals and agencies as a means of identifying important problems and building a base of information. Then, in June, a five-day working conference was held at Woods Hole, Massachusetts in order to further define a tractable number of specific problems for systematic study and to assist in planning the subsequent tour of South Vietnam. The conference was attended by twenty-three specialists in various fields including tropical ecology, forestry, agricultural economics, microbiology, soil

science, plant physiology, herbicide chemistry, photogrammetry, medicine, and anthropology.

Eleven of the participants had various degrees of experience in Southeast Asia. Although all were present as private individuals, they included persons from universities in the United States and abroad, from industry, and from several departments of the U. S. Government.

In Vietnam, our objectives were to improve our identification of important problems for study and to determine the facilities, methods, and geographical areas that would be most suitable for future work. We attempted to obtain enough specific information and experience to partly bridge the gap between the very limited picture of the situation available from reading and consultation in the United States and actual conditions as they exist in Vietnam. In fact, we were able to make some specific observations that should be of value even at this preliminary stage.

Although we went to Vietnam as independent scientists on behalf of the AAAS, we were given the full official support of the U. S. Mission and of the Government of the Republic of Vietnam, who showed their concern with the problem by supplying letters of introduction and every assistance in Saigon and in the provinces. Our living quarters, office facilities and ground transportation were generously and expeditiously provided by the U. S. Agency for International Development. Extremely valuable helicopter overflights and

other air trips were arranged by USAID, the American Embassy, and, especially, by the U. S. Military Assistance Command. However, our itinerary and daily activities were decided upon solely by ourselves.

We consulted with Vietnamese university and ministry specialists in botany, zoology, soil science, agronomy, chemistry, forestry, and medicine. We made several field trips with Vietnamese professors and graduate students. We interviewed numerous farmers and village officials for first hand information on herbicide effects. We conducted aerial and ground inspections of herbicide treated and untreated areas and conducted studies of possible health and congenital anomaly changes in selected regions. Food-chain components and human sample materials were collected and brought back for chemical analysis.

LAND AND PEOPLES OF SOUTH VIETNAM

South Vietnam occupies the southeastern extremity of the Southeast Asian Peninsula and has a crescent-shaped area of 170,000 square kilometers. It is about 1,300 kilometers long, extending from 8°33' to 17° north latitude. Its average width is about 150 kilometers, falling between about 104° and 109° east longitude. To the west lie Laos and Cambodia, to the east the South China Sea.

Populations: The 1970 population of South Vietnam is estimated to be 17.5 million, concentrated in the southern third of the country and in a narrow strip along the eastern coast. More than 80 percent are ethnically Vietnamese. The largest minority are the Highlanders of Montagnards, a group of tribal peoples racially and linguistically distinct from the ethnic Vietnamese. Estimated to number approximately one million, the Montagnards are distributed throughout the upland areas in the northern two-thirds of the country.

Geographic Regions: South Vietnam is divisible into four main physiographic regions. The Mekong Delta region constitutes the southernmost quarter, extending over about 40,000 square kilometers with about 5 million inhabitants. Flat and often marshy, it is dissected by the five arms of the Mekong River, several lesser rivers, and many navigable streams and canals along which the rural population is concentrated. The rivers are so sediment-laden that in some places the coastline advances by as much as 75 meters per year.

The very fertile central part, where most of the Delta population live, is the principal rice production area in Vietnam and also is a major source of coconut, banana, and other fruits. In the northern portion of the Delta, extending from the Cambodian frontier, there lies an extensive, poorly drained marsh, the Plain of Reeds. Mangrove forests line much of the coast of the Delta and occupy two particularly large areas, the Camau Peninsula in the far south, and the U Minh Forest in the west.

The Mekong Terrace region constitutes a wide band lying north of the Delta region, extending from Cambodia to the sea. Its area is about 30,000 square kilometers. Somewhat more elevated than the Delta but still mostly flat, this region is heavily forested in the north and mostly cleared for farming in the south. It possesses a wide variety of soils and drainage conditions, supporting not only rice but many other crops, including fruits, fibres, sugar and rubber. The population is approximately six million, half of it in Saigon and its environs. Two of the principal rivers of this region, the Saigon and the Dong Nai, join just south of Saigon and then branch into a complex of meandering channels in a mangrove forest known as the Rung Sat. One of these channels is the main shipping route linking Saigon to the South China Sea.

The Highland region of South Vietnam, occupying about 65,000 square kilometers but containing only about a million people, extends northward from the Terrace region all the way to the demilitarized zone which

divides Vietnam at the seventeenth parallel. On the east it is bounded by the Truong-Son range, which rises steeply out of the coastal plain, and on the west by Cambodia and Laos. The Truong-Son slopes gradually to the west forming an area of rugged mountains and plateaus penetrated in places by low plains opening into Cambodia.

As recently as twenty years ago this region was inhabited almost entirely by Montagnards. Even now, after a major influx of lowland Vietnamese, the Montagnards constitute more than half of the population.

Most of the Highland region is forested. There are also large areas covered with grass, brush, or bamboo. A large fraction of the forest is kept at an early stage of development by the Montagnard practice known as swidden agriculture. The forest is cut and burned, farmed for rice, vegetables, and other crops for two or more years until the land loses its productivity, and then allowed to lie fallow for several years before the cycle is repeated.

Although most of the inhabitants of the highland region are subsistence farmers, there is intensive commercial cultivation of vegetables, fruits, coffee, tea, and rubber in some areas. The large-scale production of vegetables for the Saigon market in the vicinity of Dalat is particularly noteworthy.

The Coastal Plains region, covering about 25,000 square kilometers, is a narrow strip located between the mountains and the sea,

extending from the Mekong Terrace region north to the seventeenth parallel. The strip is constricted in several places where branches of the Truong-Son range reach nearly to the sea, forming a series of large coastal plains. The population is approximately four million. Little of the region is forested, most of it being planted to rice, manioc, sweet potato, peanuts, and sugar cane.

Climate: South Vietnam has a warm humid climate. The mean temperature is 25-27°C and the average yearly precipitation is approximately 150 to 300 cm, depending on location. The seasonal range of temperatures is not large, less than 5°C in most places. Precipitation, however, is subject to great seasonal variations. In all regions except the Coastal Plains, the wettest season occurs in the summer when the prevailing winds are southwesterly, bringing warm humid air from the Gulf of Siam and the Bay of Bengal. During this time the rains are usually not steady, but occur as heavy afternoon showers. A pronounced dry season occurs during the winter, when the wind is generally from the northeast. On the Coastal Plains, the dry season starts late in the winter and lasts approximately half the year. In this region, rainfall is highest in the autumn, with serious flooding in some years. In the late autumn, the entire east coast of South Vietnam is subject to typhoons coming from the South China Sea.

Land Cover: The cover types of South Vietnam are estimated to be distributed as follows:

<u>Forest</u>	<u>Square Kilometers</u>
Hardwood	100,000
Mangrove	2,800
Rear mangrove	2,000
Rubber	1,000
Pine	<u>1,800</u>
Approximate total forest area	107,600
<u>Other</u>	
Brush wood, coffee and tea plantations	11,000
Crops	37,000
Savannah	1,300
Dune grass and trees	1,100
Swamps and marshes	8,500
Urban areas	100
Water and unaccounted	<u>7,200</u>
Total area	173,800

Under the designation "forest" are included all lands with trees whose crowns cover more than twenty percent of the area. Only about half of the total forest area is stocked with trees of sufficient size for commercial logging. Thus, the area covered by merchantable hardwoods is approximately 50,000 square kilometers. Of this, about two-thirds is in the Central Highlands and one-third in the Mekong Terrace region in a broad arc extending across the country north of Saigon.

Administrative Divisions and Military Regions: South Vietnam is administratively divided into forty-four provinces, plus six autonomous

municipalities. Each province is divided into a number of districts which are subdivided into villages. Each village contains several hamlets.

For military purposes, provinces are grouped into four Military regions, formerly known as Corps Tactical Zones. Military Regions III and IV generally correspond to the Meklong Terrace and the Mekong Delta regions, respectively. The northernmost five provinces comprise Military Region I, while the twelve remaining provinces to the south make up Military Region II, both regions include highlands and coastal plains.

MILITARY USE OF HERBICIDES IN SOUTH VIETNAM

The military use of herbicides in South Vietnam began on an experimental scale in 1961. It became operational in 1962 with the aerial spraying of twenty square kilometers of forest and three square kilometers of crop land. Much of the spraying that year was conducted in the mangrove forests of the Camau peninsula, at the southern extremity of the country. In successive years, the use of herbicides grew rapidly, reaching a peak in 1967 and then declining somewhat in 1968 and 1969. Data for 1970 is not yet available. An estimate of the area treated in each year through 1969 is as follows:

Estimated Area Treated with Herbicides
in South Vietnam*

Year	<u>Acres</u>			<u>Square Kilometers</u> (1 km ² = 247 acres)		
	Forest Land	Crop Land	Total	Forest Land	Crop Land	Total
1962	4,940	741	<u>5,681</u>	20	3	<u>23</u>
1963	24,700	247	<u>24,947</u>	100	1	<u>101</u>
1964	83,486	10,374	<u>93,860</u>	338	42	<u>380</u>
1965	155,610	65,949	<u>221,559</u>	630	267	<u>897</u>
1966	741,247	101,517	<u>842,764</u>	3,001	421	<u>3,422</u>
1967	1,486,446	221,312	<u>1,707,758</u>	6,018	896	<u>6,914</u>
1968	1,267,110	63,726	<u>1,330,836</u>	5,130	258	<u>5,388</u>
1969	1,221,415	65,700	<u>1,287,115</u>	4,945	266	<u>5,211</u>
1970	DATA	NOT YET	AVAILABLE			
Total	<u>4,984,954</u>	<u>529,566</u>	<u>5,514,410</u>	<u>20,182</u>	<u>2,154</u>	<u>22,336</u>

*The number of acres treated is calculated by multiplying the gallons of herbicide used by one-third. This procedure is based (cont. on following page)

Herbicides Used in Vietnam. Three different formulations account for nearly all of the herbicides disseminated in Vietnam. They are known by the designations Orange, White, and Blue, corresponding to the color of the stripe painted around the 55-gallon drums in which they are shipped from the United States. They are used in Vietnam as received, without dilution. Their compositions as well as that of agent Purple, an early formulation very similar to Orange, are shown in Table 1.

Orange has been the most extensively used, accounting for approximately sixty percent of all herbicide consumption in Vietnam. It is an undiluted mixture of the n-isobutyl esters of 2,4-D and 2,4,5-T. Orange acts as both a defoliant and a systemic plant killer on broad leafed and woody vegetation. It has been used mainly for forest clearing and to a lesser

* (continued from preceding page) on the fact that the average spraying rate is taken to be approximately three gallons per acre of defoliated swath produced. The quantity of herbicide used is known rather accurately but the estimation of the average area of the spray swath could be somewhat in error. For example, records of actual spray flights suggest that at least under some conditions approximately 1.4 acres of swath are produced for each three gallons of herbicide sprayed. The total area estimates given here are subject to at least two additional corrections. However, neither is very great. First, the calculated areas should be increased to take account of spraying by helicopters and by ground equipment. This is not included in the estimates given in the table, which refer only to spraying done by C-123 fixed-wing aircraft. Judging from the reported total amount of herbicide used by all types of equipment in 1968 and 1969, it appears that no more than twenty percent was applied by means other than C-123 aircraft. Second, the calculated areas should be reduced by a factor estimated as at least sixteen percent, because of the fact that some areas have been treated more than once. As these two corrections tend to cancel each other, and as neither is very great, they are not taken into account in the table.

Table 1

MILITARY HERBICIDES

Agent ORANGE: 2,4-D and 2,4,5-T

Active Ingredients: A 1:1 mixture of the n-butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid.

Concentrations: 4.1 and 4.4 lb./gal.

Application: Undiluted at 3 gal./acre.

Agent WHITE: 2,4-D and Picloram

Active Ingredients: A 4:1 mixture of the tri-iso-propanolamine salts of 2,4-D and 4-amino-3,5,6-trichloro-picolinic acid in water.

Concentrations: 2.0 and 0.54 lb./gal.

Application: Undiluted at 3 gal./acre.

Agent BLUE: Cacodylic Acid

Active Ingredients: A 6:1 mixture of sodium dimethyl arsenate and dimethyl arsenic acid in water.

Concentration: 3.1 lb./gal.

Application: Undiluted at 3 gal./acre.

extent for crop destruction. In tropical dicotyledenous forests, leaf fall occurs in three to six weeks after application, with surviving trees or branches refooliating within a year. Similar formulations are known on the domestic herbicide market under the generic name of brush killers. One of these, differing slightly from Orange by containing isobutyl 2,4,5-T as an additional ingredient was used in Vietnam until 1965 under the name Purple. The use of Orange was ordered stopped by the Department of Defense in April 1970, because of concern arising from tests on laboratory animals showing commercial samples of 2,4,5-T to be teratogenic.

The next most commonly used herbicide is agent White, a water solution of the tri-isopropanolamine salts of 2,4-D and picloram, together with surfactants and a rust inhibitor. Accounting for approximately thirty percent of total herbicide consumption, it was first introduced in quantity in 1967 when the military demand for Orange outstripped the U. S. production capacity for 2,4,5-T. White is mainly used for forest clearing, giving somewhat longer lasting results than Orange. Similar formulations are used in the U.S. for spraying power line rights of way, although picloram is not permitted for agricultural applications.

Agent Blue is a water solution of the sodium salt of cacodylic acid (sodium dimethyl arsenate), plus surfactants, rust inhibitor, and anti-foam. It makes up somewhat less than ten percent of all herbicide used.

It acts to desiccate or dry out vegetation with which it comes into contact. It is more effective on grasses than Orange or White and acts more rapidly, withering all types of vegetation within a few days. It is used both for defoliation and for crop destruction, particularly against rice.

Picloram, 2,4-D, and 2,4,5-T are all known as plant growth regulators and cause similar physiological responses, including defoliation, stimulation of growth, induction of callus formation, and striking changes in the shapes of stems, fruits, leaves, and other plant parts. These herbicides may be absorbed either through the leaves or the roots. Under some conditions, herbicide deposited on the leaves causes them to fall before enough is transported to cause systemic poisoning of the entire plant. In such cases the plant often recovers. The biochemical mechanisms of action of these chemicals are unknown, in spite of a great deal of research. However, the main cause of plant death following systemic poisoning appears to be unbalanced growth of tissue, particularly phloem, resulting in blockage of nutrient flow, and in the formation of lesions vulnerable to microbial infection.

Method of Application. Herbicide spraying in Vietnam is done by fixed-wing aircraft, helicopters, and various types of ground equipment. The principal means of application has been the twin-engine C-123 cargo aircraft. Between January 1962 and January 1969, C-123s made more than 19,000 individual spray flights. The aircraft is fitted with a 950-gallon tank

from which the liquid herbicide is pumped at approximately 250 gallons per minute to spray booms under each wing and to a third boom at the tail. It is discharged through thirty-two nozzles of 9.5 millimeter internal diameter distributed along the three booms. When the herbicide hits the airstream, it is dispersed into droplets having a mass mean diameter of 0.35 millimeters. One aircraft produces a rather sharply defined swath of affected vegetation approximately 85 meters wide and 15 kilometers long, depending somewhat on operating conditions. Records of individual spray flights suggest that some swaths are up to 100 meters wide and 18 kilometers long. Standard operating conditions are an air speed of 240 kilometers per hour and an altitude of 50 meters above tree top level.

In order to minimize inadvertent applications from drift and volatilization, spraying is not supposed to be done when wind speed exceeds 15 kilometers per hour or temperature exceeds 29°C. Calculations based on assumed drop size distributions suggest that even with a 15 kilometer per hour wind, drift should not be an important problem beyond about 3 kilometers from the line of application. However, the actual drop size distribution for the C-123 equipment has not been measured in the field.

Aerial spraying by helicopter is done by the UH-1 "Huey" aircraft mounting a 200 gallon tank. For crop destruction missions, the application rate is sometimes reduced to about half the value delivered by C-123, since even about 1 gallon of Blue per acre is enough to prevent the maturation of rice.

Location of herbicide applications. No systematic and detailed information on the locations of herbicide spraying in Vietnam has been made generally available. However, the U. S. Army Chemical Staff in Saigon has kept a log for each C-123 mission since July 1965. Records for spraying before that time may be on file in official archives kept in Omaha, Nebraska, and St. Louis, Missouri. The log in Saigon includes the data most relevant to any study of herbicide effects. These are the dates and map coordinates of spraying, the type of herbicide, and the quantity actually sprayed. Map coordinates are given to the nearest 100 meters. At present, this information is classified Confidential.

Although truly satisfactory information is unavailable at present, it is possible to put together a rough idea of the amount of terrain of different types that has been sprayed and of the location of the principal areas of heavy exposure. This has been done on the basis of published information and aerial observations made by ourselves and by others.

Tropical Hardwoods. The greatest expenditure of herbicides in Vietnam has been on fairly mature tropical hardwood forest. Flamm places the area of such forest sprayed through 1969 at 13,500 square kilometers, about a third of it sprayed more than once. Hardwood forests of one kind or another and in various conditions make up about nine-tenths of forested land in south Vietnam. The forestry services of the French colonial government estimated the total area of economically valuable hardwood

forests at 50,000 square kilometers, leaving out forests that were badly degraded, very young, or located on particularly inaccessible mountain terrain. A recent estimate of the total hardwood forest estate, based on low resolution aerial photography and on U. S. Army terrain travel difficulty maps is 100,000 square kilometers. However, this includes a large fraction of the forest in the central highlands that is kept at a very early successional stage by swidden agriculture. An intermediate value, about 75,000 square kilometers, can be estimated from a vegetation map published by the Government of Vietnam. As a rough approximation then, it appears that some twenty percent of the relatively mature hardwood forest has been treated with herbicides, a third of it more than once.

Mangrove and Rear Mangrove. To the southwest of Saigon, and along much of the coast of the Delta, are dense mangrove forests covering about 3,000 square kilometers. According to Tschirley, about one-third of this forest type had been sprayed by the end of 1967. With continued herbicide operations in the Delta, the proportion is now probably close to one half. Inland from the mangroves in the western part of the delta are nearly 2,000 square kilometers of forests of Melaleuca leucadendron, sometimes called rear mangrove. We are unaware of how much, if any, of this forest type has been sprayed,

Strip Spraying. Aside from blocks of forest within which herbicides have been extensively applied, a considerable amount of spraying has been done in short narrow strips scattered widely throughout South Vietnam. Strip (as opposed to bloc) spraying has been done along roadsides, perimeters of military installations and also in forests. In the Delta, it has been done along canals and rivers. Although much of it has been accomplished by C-123s, a large fraction has been done by helicopters and therefore may not have been systematically recorded.

Crop Destruction. Finally, somewhat more than 2,000 square kilometers of cropland is reported to have been sprayed. If little of this area includes re-spraying, it would represent about five percent of the 38,000 square kilometers of crop land in South Vietnam of which a little over two percent was sprayed in the peak year of 1967. Being located almost entirely in the central highlands, rather than on more productive soil, the percentage of the total national crop production affected would be less than the percentage of South Vietnamese farmland that has been sprayed. However, only about a tenth of South Vietnam's farm land is in the highlands, so that within this region a considerable fraction of the farmland has been sprayed.

HERBICIDE TOXICOLOGY: STILLBIRTHS AND BIRTH DEFECTS
HAC OBSERVATIONS AND PROBLEMS FOR STUDY

The following is an analysis of the work which was done by the HAC in the evaluation of the feasibility of demonstrating any change in the pattern of births in Vietnam which might have resulted from the exposure of some of the Vietnamese population to 2,4,5-T, or its contaminant dioxin, agents which have been reported to be teratogenic under certain laboratory conditions in / certain animals.

If indeed any such effects of the 2,4,5-T exposure on the Vietnamese population are to be detected, it would be appropriate to study these in at least four ways, looking for:

1. Changes in the occurrence of malformations and/or still births in a relatively stable population.
2. Changes in the frequency of any of the more common identifiable malformations in relation to other common malformations.
3. The relatively sudden appearance of an otherwise very rare or unknown deformity in significant numbers (the classical previous example being thalidomide induced phocomelia).
4. Changes in the incidence of specific abnormalities, anatomical or biologic, that have been shown to result from laboratory experiments with 2-4-5,T in animals.

Consideration will be given to each of these possibilities. All of them are somewhat difficult to examine precisely but numbers two and three are, we

believe, subject to relatively precise evaluation even under war time conditions in Vietnam, while the first and last are a great deal more difficult to elucidate. These methods of study are all subject to very significant limitations, some of which are now presented.

Size and Accessibility of the Population Exposed Directly to Herbicides. Although, as frequently noted/precise information as to all the locations of herbicide spraying has not been made available to the HAC; and it is therefore, difficult to be certain how much defoliation has in fact been done in more densely populated areas, it nevertheless appears to be true that the bulk of Agent Orange used in Vietnam has been sprayed in relatively remote and sparsely populated areas of mangrove and other forests. This figure is particularly hard to estimate since the crop destruction program is carried out in more populated areas and although Agent Blue (without 2,4,5-T) has been favored for this, Agent Orange has also been used.

The population directly exposed to 2,4,5-T presumably does not exceed five percent (and may even be one percent or less) of the total population of Vietnam, although this must be more accurately determined from precise spray data. This factor alone strikingly dilutes any/^{apparent} effects of the spraying on birth statistics / ^{when} those directly exposed are added to the total statistics of the country, but this effect is even more accentuated by the fact that most of this population is necessarily in remote and usually insecure areas and therefore information regarding medical effects, if any, can only be gradually expected to filter out from the sites of direct exposure. An unknown proportion, but probably quite significant, of the exposed population, consists of

Montagnard people whose births are normally at home or in villages and are rarely recorded in the Government of Vietnam medical system or allowed for in the GVN statistics.

Status of Records: Availability and Accuracy. In general, maternity records are in some respects among the most reliable available to the field investigator in Vietnam. Traditionally, midwifery in Vietnam has been strictly independent and, employing female midwives, has been rather less subject to change of personnel than has the rest of the Vietnamese health system. In all hospitals or dispensaries staffed by a midwife, whether national or rural, a daily record book is kept in which all deliveries are recorded. It is agreed by almost all observers that this record, providing the original has not been lost, is reasonably accurate as far as the limited information it contains. Thus, it is our feeling that almost complete accuracy is available concerning the number of births, sex of the children, weight of the newborn and whether or not the infant survived. In theory, obstetrical abnormalities or infant malformations are recorded. If these are positively noted in a record, then they are reliable, at least within the diagnostic acumen of the midwife recording them, but, as will be shown subsequently a negative record is of no significance whatsoever. It is our belief that within these simple statistics, the accuracy of provincial hospitals, district hospitals, and village dispensaries is comparable. This assumption may not be strictly true and is subject to factors such as the desirability of registration of living children, which might lead to the concealment of a stillbirth or neonatal death, or the reluctance of village or district midwives to report

large numbers of stillbirths when transfer of difficult cases to the provincial hospital is expected by the Ministry of Health. Nonetheless, the uniform agreement of numerous Vietnamese doctors and midwives with whom we consulted that this reporting is usually reliable, supports our opinion. In the capital area (Saigon-Gia Dinh) modern statistical methods have been introduced, particularly at Tu-Du, and increasing accuracy is reflected thereby.

The Vietnamese Health System. The Ministry of Health provision for the medical care of the people of Vietnam is through a system of rather strictly graded medical facilities. A village will often, but not always, contain a dispensary of extreme simplicity staffed by a rural health worker and/or midwife with only a few months training. Nonetheless, in one province studied by the HAC nearly twice as many births were recorded in village dispensaries as in the provincial hospital for a comparable period.

All district capitals have a dispensary and at the time of the visit of the HAC it was reported by the Ministry of Health that all of these were at least partially staffed. Personnel usually include national health workers and midwives, many of whom are well trained, but these facilities do not normally have a doctor available and except for deliveries usually do not have in-patient facilities. In the province studied in detail by the HAC the district dispensaries delivered somewhat fewer children than the provincial hospital.

All provincial capitals have a hospital with doctors as well as nationally trained nurses and midwives. There is a very wide range of quality among these facilities and some overlap, with certain district dispensaries better staffed and equipped than some provincial hospitals. In addition, there are the medical facilities in the larger cities, not provincial capitals, including Da-Nang and Saigon. These include specialty hospitals and, in general, the best facilities in the country.

Because of their accessibility and concentration of more interesting patients, most studies of Vietnamese medical statistics have been made at the level of provincial and city hospitals although most patients, and particularly a large number of deliveries, are, in fact, cared for at the district and village level. Records of these smaller facilities show a strikingly lower level of stillbirths and obstetrical difficulties than do provincial hospitals. This is believed to be a true statement of the facts by Ministry of Health officials and the HAC, and presumably reflects the referring of difficult cases to provincial or city hospitals. Military security and adequacy of transportation will, of course, improve the degree of referral and tend to increase the differential reported between the two groups of reporting hospitals. In the capital, approximately one quarter of the babies are delivered at Tu Du, a large teaching hospital devoted exclusively to maternity, another quarter are delivered at other government hospitals, and about one-half at private maternities. These latter are very quick to refer patients to

the government hospitals and report essentially no complications for fear of difficulties with the Ministry of Health. In this respect, it is of interest to note that nearly one-half of the total maternal deaths reported by Tu Du in 1965 were, in fact, referred "in extremis" from outside hospitals. The official health statistic report of the government of Vietnam for 1967 states: "Moreover, private maternities dare not tell the truth on the deaths of who came for delivery."

The registration of births in the Republic of Vietnam is still very incomplete. It is believed that close to all of the births in the capital area are registered. In the remainder of the country, current government estimates are that about one-half of all births are registered in any form and, as we shall see in the case of Tay Ninh, the provincial hospital itself may not be an accurate reflection of figures for the entire province. Although we emphasize the accuracy as to birth weights and stillborns of the midwife record books when they can be consulted in their original form it cannot be over-stressed that the recording of congenital abnormalities is extremely patchy and seems to reflect the interest of the midwife at different periods. The midwives from whom we received such good help in this study nearly uniformly agreed as to this deficiency.

Even when malformations are recorded, their nature is often incompletely noted. Only in the capital is cleft palate distinguished from cleft lip in the records and a number of midwives agreed that the inside of the mouth of the infants was almost never examined. The nature of fatal anomalies is very rarely recorded and essentially no autopsies are performed on stillborns.

Rates of Stillbirths and Reported Congenital Anomalies in the Capital and Provinces. The extensive study of congenital malformations hydatidiform moles and stillbirths in the Republic of Vietnam 1960-1969 carried out under the auspices of the Department of the Army and the Vietnamese Ministry of Health by a team headed by Dr. Robert T. Cutting has now become available and most of the more limited investigations carried out by the HAC will be related to this major army undertaking. Unfortunately, in spite of persistent efforts, this material was not available to the HAC at the time of their visit to Vietnam.

Saigon. Studies of the records of Tu Du for the last decade, which include about one-quarter of registered Saigon deliveries and covering between 12,000 and 30,000 births a year, show a definite decrease in still-birth rates. There was a notable discontinuity in 1967 when the rate fell from 36 per thousand in 1966 and 38 per thousand in 1965 to 26 per thousand and remained at this lower level for 1968 and at 29 per thousand in 1969.

During the same period, there was a slight reduction in the overall rate of recorded malformations. It is the opinion of the medical staff at Tu Du that some, at least, of the reduction of the stillbirth rate is from considerably improved medical care as shown by the fact that in the years 1963-1964 no babies under a kilogram in weight survived out of 310 being born alive while in 1965 and 1966, 55 survived out of 391 delivered.

The rate of hydatidiform moles at Tu Du also dropped slightly. It should be noted that the figures for moles at Tu Du reported by Cutting do

1 only
births
seen
20-2-49
67

not include choriocarcinomas which at most provincial hospitals are included in the mole figures and would raise the Tu Du percentage by nearly twenty percent during the years 1963 and 1964.

Countrywide Data. The Cutting study reports a general downward trend in stillbirths during the period 1960-1969, taking all of the data together. This is shown by the solid line in Figure 1. Grouping these countrywide data into pre- and light-spraying years (1960-1965) and heavy spraying years (1966-1969), the stillbirth rates are found to average 36.1 and 32.0 per thousand live births, respectively. Finding a similar downward trend in moles and deformities, Cutting concludes that "Sorting the data into two time periods, before (1960-1965) and after (1966-1969) the large scale military use of herbicides, failed to show any effect of herbicides. Rather, a downward trend was observed in all categories of abnormal birth events." However, these trends are caused by the data from the capital area (Tu Du, Hung Vuong, Bien Hoa), which account for approximately two-thirds of the births studied. When the data for the capital are subtracted the trends are reversed. This may be seen below.

Abnormal Birth Events as Reported by Cutting

	<u>Rates per Thousand Livebirths</u>	
	<u>Light-spraying (1960-1965)</u>	<u>Heavy-spraying (1966-1969)</u>
<u>Countrywide</u>		
Stillbirths	36.1	32.0
Moles	6.6	5.6
Malformations	5.5	4.5
<u>Countrywide minus Capitol</u>		
Stillbirths	32.0	38.5
Moles	3.1	5.3
Malformations	2.3	3.1

Plotted year by year, the countrywide data with the capital area subtracted shows a decided upward trend, peaking in 1967, as shown by the dashed line in Figure 1.

Tay Ninh. Rather than attempting to survey the provincial hospitals from a large number of areas, the HAC concentrated their efforts on the study of possible changes in malformation and stillbirth rates in the province of Tay Ninh. Although, as in other areas where agent Orange has been used mainly for forest defoliation (as opposed to crop destruction) the total number of directly exposed Vietnamese is probably low, the northern portion of Tay Ninh has been heavily defoliated and the rivers draining the areas of defoliants run through the remainder of the province and are a source of fish for some of the population.

As has been noted by Cutting, the earlier maternity records of the Tay Ninh City provincial hospital and most of the Tay Ninh district

dispensaries are no longer available but we were fortunate in being able to study the daily record book in its original form at the provincial hospital for the years 1968 through 1970, although this was apparently not available to the army group. Study of these records was of interest and in striking contrast to the figures reported by Cutting. Although two months (November and December 1968) are missing from the original data book and only Ministry of Health summaries could be obtained, a higher rate of stillbirths, 64 per thousand livebirths, was shown from these records in Tay Ninh than recorded anywhere else by Cutting and his group. The HAC noted 351 stillbirths in the years 1968 and 1969, the years for which Cutting reports 208.* The data for Tay Ninh City provincial hospital are as follows:

<u>Year</u>	<u>Livebirths</u>	<u>Stillbirths</u>	<u>Rate per 1,000 Livebirths</u>
1968	2,765	161	58.0
1969	2,361	190	80.5
1970 (7 mos.)	1,688	171	101.0

It was very striking that among 2,551 births recorded in 1969, not a single specific congenital deformity or malformation was noted. The midwives, the chief of whom had been there for ten years, agreed that a fair number of deformities had been seen but had not been, in fact, recorded.

*It was noted that in 1969, while 184 stillbirths were reported in the summaries given at the end of each month in the data book if every birth registered was individually examined, 190 stillbirths were noted.

We were able to survey all of the reported births from village, districts, and provincial facilities in Tay Ninh for some recent months and in this way try and weigh appropriately the importance of the provincial hospital as a reporting agency.

Tay Ninh City provincial hospital has shown a remarkable monthly uniformity in births since 1967 with annual totals something under 3,000. Records have also been fairly consistent from the two larger of the

<u>Year</u>	<u>Livebirths</u>
1967 (9 mos.) [✓]	1,818
1968	2,765
1969	2,361
1970 (7 mos.)	1,688

[✓]As recorded by Cutting. Original data book unavailable to HAC.

four district dispensaries in the province. The largest, Heiu Thien, with 1,000 births per year approximates a provincial hospital as a facility. For four months in 1970 essentially complete figures are available from all of the districts and villages in Tay Ninh province as well as the provincial hospitals. These include all medical facilities reporting to the Ministry of Health and are said by their officials to include over seventy percent of total births in the district. They show that during this period, February through June 1970 (excluding April for which reports were incomplete) 2,281 births with 20 stillbirths (i.e., 8.8 per thousand livebirths) were reported

from the districts and villages with the village dispensaries accounting for about two-thirds of this number, while during the same period, Tay Ninh City Provincial Hospital reported one-half as many births, 1,028, with 89 stillbirths (i. e., 95 per thousand livebirths), more than ten times that of the outlying districts. Clearly, therefore, the birth statistics from Tay Ninh City Provincial Hospital, with a stillbirth rate of 95 per thousand, are quite different from those from all of Tay Ninh Province including villages and districts which reported a combined total of 3,309 births with 109 stillbirths or a rate of 34 per 1,000 livebirths. Although specific determinations were not made in other provinces, except partially in the Rung Sat, it is expected that differing degrees of variations of this sort will be found in all provincial capital hospital statistics as compared to complete provinces. It is noted that if the districts and villages were able to reduce their stillbirth rate by one-half, by referral, this would not be sufficient to fully explain the discrepancy in stillbirth rates. Better than fifty percent prenatal diagnosis of impending stillbirth is unlikely to be consistently possible. We do not know the reason for this striking difference in Tay Ninh. We note that all districts surveyed by Cutting in various parts of Vietnam also showed very low stillbirth rates.

An incidental study was made of the prevalence of twinning at Tay Ninh City Hospital. For the period July 1968 to July 1970 (excluding the two months in 1970 for which no figures are available) 79 multiple births occurred, including one set of triplets, out of a total of 7,010; or approximately 11.2 per 1,000, almost exactly the same figure as reported by Drs. Oliver and Hong for Saigon in 1952 to 1962.

Rung Sat. A similar, less extensive survey, of the RSSZ area was carried out. Dispensaries at Can Gio and Quang Xuyen closely bordering the defoliated mangrove forest annually reported several hundred births with very low rates of stillbirths and no deformities recorded. We were definitely informed that any patient with impending stillbirth or evidence of obstetrical complications was referred to Vung Tau. Although Vung Tau serves as the provincial hospital for this area, it is not in fact the provincial capital but an independent city. Vung Tau Hospital with a monthly birth rate very close to that of Tay Ninh showed a strikingly lower rate of stillbirths; 26 per 1,000 in 1968 and 30 per 1,000 in 1969 (9 months) and 22 per thousand in 1970 (7 months).^{*} The rate of twinning was 8.9 per 1,000 (54 out of 6,198). It is of interest that among this large number of births only one mole is recorded. This patient was transferred to Tu Du in Saigon. During the same period, a total of 6,198 births were reported with no congenital abnormalities recorded.

Although Vung Tau includes in its referral area a zone of intensive defoliation of mangroves, most of its patients may be supposed to have had minimal herbicide exposure either directly or possibly through the food chain. They apparently do not regularly eat fish from streams emanating from sprayed forests as do the inhabitants of Tay Ninh.

^{*}The actual figures were 2,569 births and 67 stillbirths in 1968; 2,179 births and 64 stillbirths in nine months of 1969; and 1,450 births and 31 stillbirths in seven months of 1970.

Conclusions. For the proper comparison of provincial birth statistics it is essential that total provincial figures including district and village dispensaries and allowance for referral out of the province be obtained. This has been done by the HAC for Tay Ninh. Other total provincial figures not being in hand for comparison, the fact nonetheless remains that Tay Ninh City Provincial Hospital, serving a heavily defoliated province, showed an average stillbirth rate in 1968 and 1969 of 68 per 1,000 livebirths. During this same time, the Tu Du rate was 27.5 per 1,000 and that of the Army sample of the entire country 31.2 per 1,000. The rate of 68 per 1,000 is higher than any reported from any provincial hospital by Cutting.

Changes in the Prevalence of Common Congenital Anomalies:

Saigon Childrens Hospital. In attempting to analyze the frequency of different congenital abnormalities in Vietnam, in contrast to their absolute frequency, we are very fortunate to have the elaborate study of all of the abnormalities seen at the Saigon Childrens Hospital prepared by Dr. Le Anh, an analysis of the 4,002 cases of congenital abnormality seen for the period 1959 to 1968. Her study is complete in that every case is evaluated and there are no "miscellaneous" or "other" categories as is characteristic of almost one-half of the malformations reported by the few maternity hospitals that do, in fact, report any significant number of deformities. Dr. Le Anh is well aware of sophisticated methods of describing and subdividing anomalies and of recent etiological considerations. Whereas, most other Vietnamese

hospitals would not distinguish cleft lip from cleft palate, if reporting the deformity at all, Dr. Le Anh carefully distinguishes them.

The annual admission rate for congenital anomalies at the Saigon Childrens Hospital has been almost the same for the years 1964 to 1968 (618, 565, 650, 667, and 554).

Saigon Childrens Hospital is the only special childrens hospital in Saigon, or in fact in Vietnam, and during these years would have received most children that could be referred for possible surgical correction of congenital anomalies. Recently the establishment of the CMRI Unit at Cho Ray has added another facility. This unit started in July of 1968. The CMRI has tended to draw patients from the provinces even more than has the Saigon Childrens Hospital, and their activity may account for the slight decrease in Saigon Childrens Hospital congenital anomalies admitted in the last year. Nonetheless, the vast majority of types of anomalies treated by the Saigon Childrens Hospital are never seen at CMRI. The CMRI from July 30, 1968 to February 1970 repaired no less than 381 cases of cleft lip and 180 cases of cleft palate.

Saigon Childrens Hospital--types of cases. Saigon Childrens Hospital does not have an obstetrical unit and they accept only cases for which surgery might be indicated and only children that survive long enough for transfer to be accomplished. Their statistics, therefore, represent a very selected group of congenital anomalies but among these their statistics should reflect any relative change of frequency.

Saigon Childrens Hospital--sources of patients. Although Dr. Le Anh's report does not analyze the individual provincial origin of each of the 4,002 anomalies, there is an analysis of provincial origin of all cases over the years. Of 4,002 admissions, 1,572 came from Saigon and Cho Lon,

910 from Gia Dinh, 293 from Long An, 164 Dinh Tuong, 162 from Bien Hoa, all of these being rather near the capital. Eight other provinces sent in fifty or more cases during the decade and each of the other provinces of South Viet Nam supplied a few cases. The Saigon Childrens Hospital series, therefore, predominately represents material from the capital and surrounding areas but all of the country is represented.

Saigon Childrens Hospital--Deformities Treated in Relation to Numbers Treated by Maternities. In the years 1964 to 1968 Tu Du reported about one-quarter of all Saigon deliveries including a total of 680 malformations, approximately one-half of which survived. During the same period, the Saigon Childrens Hospital admitted 3,054 cases of which about 1,900 were from Saigon. Even if every one of the surviving anomalies from Tu Du (340) were, in fact, admitted to the Saigon Childrens Hospital and these represented a quarter of all of those born in Saigon, then at the most only something just over half of all malformations occurring were being reported by the capital area maternities. It would appear that completeness of recording by maternities is very different for different types of congenital anomalies. Some obvious anomalies such as cleft lip would appear to be fairly accurately reported. During these same years, Tu Du reported 132 surviving patients with cleft lips. During this time, Saigon Childrens Hospital admitted 408 cleft lips, 55 cleft palates and 83 combined cleft lip and palates or a total of 546 cleft lips of all types of which about 380 originated in Saigon. If all of the

children with cleft lips were in fact referred to the Saigon Childrens Hospital and if Tu Du was reporting one-quarter of those born in Saigon these figures would be consistent with reasonably accurate reporting by Tu Du.

Other deformities are grossly incorrectly reported and one of the most interesting of these is imperforate anus. This, except in the very rare forms where the obstruction is not at the anal orifice itself, is very easy to recognize, has been known for a long time, is subject to surgical repair and although requiring correction is not immediately fatal so would not result in the victim's being reported as a stillbirth. The Saigon Childrens Hospital figures show that this is one of the commonest abnormalities admitted there with 453 cases being admitted in ten years. In 1964, 1965 and 1966, Tu Du reported only eight surviving cases of imperforate anus. During the same period, Saigon Childrens Hospital admitted 189 cases, about 120 coming from Saigon. It is of some interest that Cutting in his list of all reported malformations among 480,087 live births reports only six cases of imperforate anus from all maternities when very many more would have been expected. As another example, the Saigon Childrens Hospital reports 44 cases of spina Bifida during the decade with Tu Du reporting only 3 cases during most of this period and Cutting reporting only 8 cases out of 480,087 live births in the same period.

Changes in Certain Anomalies. The figures from Saigon Childrens Hospital show no apparent change in the relative frequency

40

	CKP	ob.
B	43	35
A	25	33

	CKP	ob.
E	35	8
H	21	48

of any anomalies aside from the three exceptions detailed below.

$$\frac{729}{35} + \frac{729}{21} =$$

$$20.8 + 34.7 = 55.5$$

Year	Total Cases	Spina Bifida	Club Foot	Cleft Palate	Cleft Lip*
1959	61	2	3	0	2
1960	214	1	2	1	40
1961	196	3	1	1	17
1962	2612	335	0	1	48
1963	1151	142	0	0	17
1964	3127	618	2	5	102
1965	4020?	565 ?	1	2	60
1966	4553	650	1	12	69
1967	4163?	651 or 667	8	23	110
1968	4974	554	2	13	67

* Figures given for comparison.

7: 24.616

The number of club feet reported is so small, and so small a percentage of those born are referred to the Saigon Childrens Hospital, that these figures are recorded for completeness only. Great caution is necessary in any interpretation of these figures. Although the total cases seen at Saigon Childrens Hospital of both spina bifida and cleft palate have shown significant increase the relative rates (to total admission for congenital defects) were fairly high in the period 1959-1963. During this time the hospital was subject to severe vicissitudes--political and other--and it may well be that serious anomalies absolutely requiring treatment such as most cases of spina bifida but not cleft palate would relatively increase, but this is only a supposition. The increase in spina bifida in 1967 and 1968 may be because of better recognition by x-ray but Dr. Le Anh in noting this rather striking increase, did not consider this possibility and Dr. Tran Ngoc Ninh, chief of the Saigon Childrens Hospital, could offer no explanation for the

Using total
multiplication

B
A

1967-1968

increase. The change in cleft palate frequency may, of course, reflect better examinations with the patient's mouth being open. Recent enthusiasm and availability of cleft lip repair has increased the search for these cases--often by American soldiers--and some pure cleft palate may have been incidentally brought to treatment. The repair in 1968-1970 of 180 cleft palates at CMRI is of interest but we have not determined how many of these were pure cleft palates without associated cleft lip as is true of the Saigon Childrens Hospital series. Careful studies are certainly indicated as to the nature, provincial origin and future frequency of these cases.

Conclusions. Most surgically correctable congenital anomalies treated by the Saigon Childrens Hospital have shown no major change in their relative frequency of occurrence during the last decade. There are two notable exceptions to this. The occurrence of spina bifida and pure cleft palate (without associated cleft lip) have both shown unexplained increases during the last three years but as noted many factors may have caused this numerical increase at Saigon Childrens Hospital.

The Occurrence of Rare Striking Anomalies. Three principle sources of information are available to try and determine whether any striking visible unusual anomaly has occurred in Vietnam in recent years. It is to be remembered that any anomaly that resulted in a stillbirth is unlikely to be noted. Autopsies are not being performed and the nature of monsters is not being recorded. Only an easily detectable non-fatal anomaly would

be observed. It is the belief of the HAC that such changes have, in fact, probably not occurred on the basis of three principal sources of information.

1. The Saigon Childrens Hospital report which shows no listing of a new or striking abnormality. Saigon Childrens Hospital might not have been aware of an anomaly that was not appropriate for surgery. On the other hand, the author of this study is fully familiar with, for example, thalidomide induced phocomelia, and no suggestive anomalies appear on the total list.
2. Another source of information is the Minister of Health, Dr. Tran Minh Tung, who felt confident that even a single case of any striking phocomelia type abnormality born anywhere within the government system would be reported to him within a short time and who was unaware of any such changes in spite of a certain number of suggestive articles in the Vietnamese press.
3. Perhaps the best source is Father Lichtenberger, Professor of Genetics at the Faculty of Saigon, geneticist to Tu Du Hospital and the best known expert on chromosome abnormalities in Vietnam. He has lived in Vietnam for many years and has seen many of the interesting monsters of one sort or another occurring in Saigon and some of the other parts of the country. He has not been aware of any suggestive changes.

Changes in the Indidence of Specific Abnormalities Related to Laboratory Experiments. Laboratory experiments in animals with 2,4,5-T indicates toxicity to the gastro-intestinal tract with hemorrhage and other changes. Cystic kidneys have been demonstrated as well as a few cases of cleft palate in the offspring of exposed pregnant animals.

Specific search has not been made among the exposed Vietnamese population for gastro-intestinal tract or urinary tract changes that might be present. It must be remembered that only a very small percentage of congenital abnormalities and malformations are visible and easily detected. Many biochemical and other occult abnormalities, although with significant effects on life expectancy, only can be demonstrated with laboratory study generally unavailable in Vietnam.

Conclusion: Laboratory study would indicate that possible teratogenic effects of 2,4,5-T may be of a nature very difficult to identify in Vietnam.

Overall Conclusions: Studies of changing rates of stillbirths, particularly as reported by the government maternity system are subject to great errors of interpretation even when they are made somewhat more valid by the inclusion of total provincial figures. Although the reported rate of stillbirths in Tay Ninh province, extensive areas of which were treated by 2,4,5-T, are higher than the highest provincial hospital rates reported by Cutting, this type of evidence is not sufficient to draw any firm etiological conclusion. The same must be said of the sharp upward trend in stillbirths

recorded by Cutting for areas outside of the capital. Even more difficult is any estimate of the rate of congenital malformations, the variations in the reporting by different maternities making the figures useless for statistical comparison.

There has been a considerable increase in the cases of spina bifida and cleft palate (without cleft lip) reported at the Saigon Childrens Hospital. Otherwise, the HAC is fairly confident in reporting that there has been no significant change in frequency of any of the relatively common congenital anomalies consistent with life that might appear at a childrens hospital among those patients presenting themselves for treatment in the GVN health system. The HAC found no evidence of any new striking abnormality of a congenital type and consistent with life occurring in Vietnam in recent years but this statement is made with the recognition that much of the directly exposed population is unavailable for study at this time.

Future Direction of Studies. The following areas would seem to require more exhaustive investigation along the lines of thought of the preceding chapter.

1. With the aid of local Vietnamese authorities and, it is to be hoped, with the complete spray data available from the U. S. Department of Defense, the Vietnamese population exposed to 2,4,5-T could be much more precisely identified and isolated and the individuals studied for possible effects of the agent.

This would particularly include very careful studies of gastro-intestinal tract, urological tract and biochemical changes of children born after exposure.

2. In specially selected defoliated areas of the country, more careful autopsy of monsters and other stillborns and neonatal deaths with congenital abnormalities should be carried out.
3. Further study is certainly indicated of the incidence of spina bifida and cleft palate in Vietnam with particular study of the provincial origin and possible herbicide exposure of the patients involved.
4. Further careful provincial studies of rates of stillbirths with efforts to accumulate data from all of a number of provinces both sprayed and unsprayed for comparison should be done.
5. Those children with defects should have careful studies as to their origin and possible exposure to 2,4,5-T.
6. Notes should be further taken of reported ill effects of 2,4,5-T by both GVN and NLF, including chromosome changes reported by the latter, and study made seeking for these effects specifically among the Orange exposed population.

Figure Legend

Figure 1: Incidence of Stillbirths per One Thousand Live-births, 1960-1969. Data are from the U. S. Army-GM Ministry of Health study by Cutting, et al. The anomalously high stillbirth rate for 1960 for births outside the Capital is based on relatively few reports.

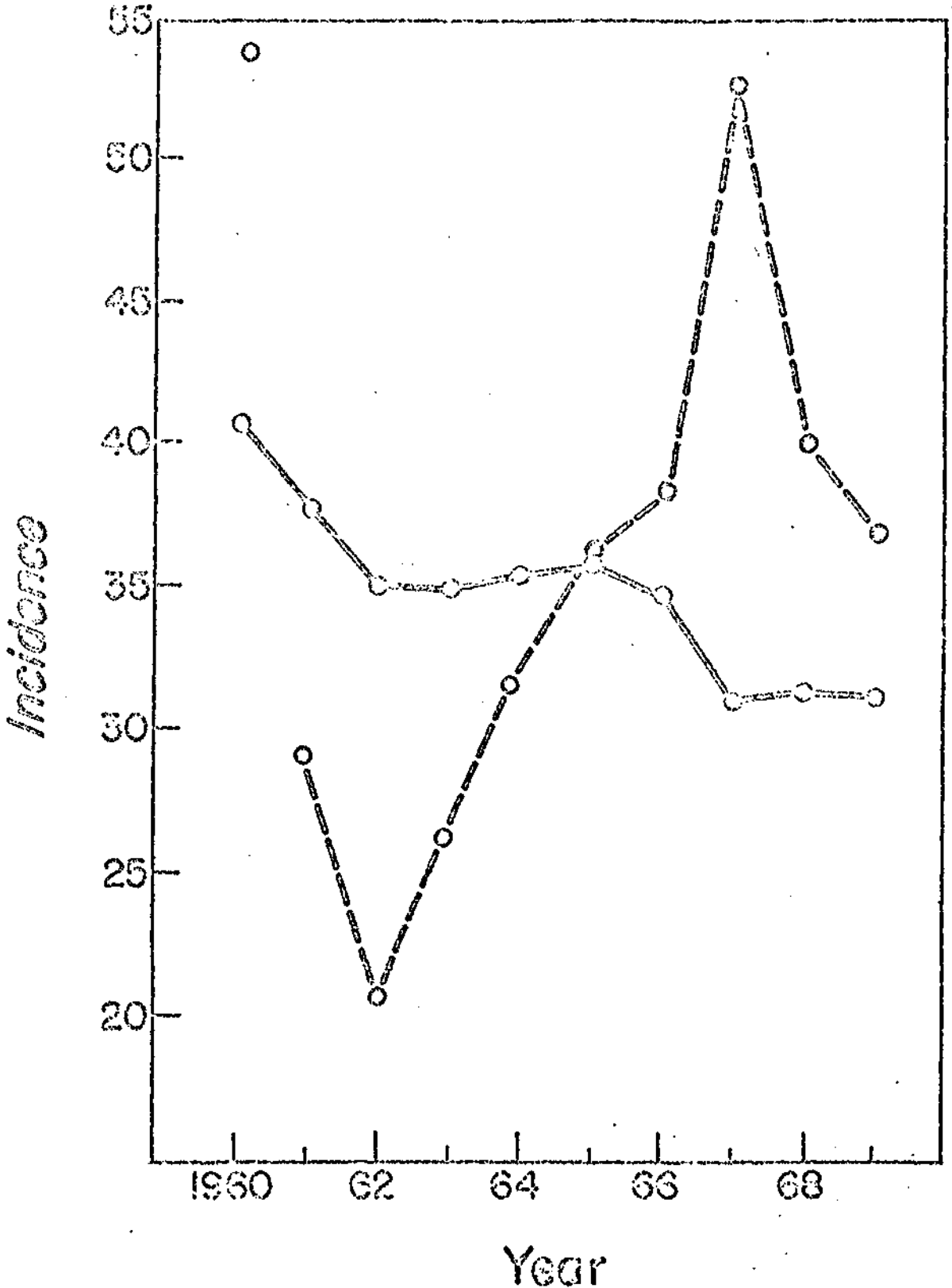
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Total

- - -○- - -

Total minus Capital Area (Saigon-Bien Hoa)

Incidence of stillbirths
per 1000 livebirths
1960-1969



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