US CHEMICAL WARFARE AND ITS CONSEQUENCES

DOSSIER

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FOREWORD

From 1961 to 1971, the Pentagon conducted a systematic chemical war in South Vietnam, spraying vast agricultural and forest areas with herbicides and defoliants "used in concentrations much higher than in agriculture, and in such conditions that their effects go far beyond those required in agriculture." (Resolution of the International Conference of Scientific Workers on Chemical Warfare in Vietnam, held in Orsay, France, from December 12-14, 1970). *For what it called defoliation operations the US Command used C-130, C-123 and C-47 cargo planes converted into spraying planes, and later had hundreds of helicopters (HU-1A, H-34, HU-1B, AIE) fitted with a spray system called Fidal, which could be used effectively even on small paddy fields and orchards. Among the defoliants used were 2,4-D and 2,4,5-T (dichlorophenoxyacetic acid and trichlorophenoxyacetic acid) which were first*

produced in 1941 at the Biological Weapons Research Centre at Fort Detrick, Maryland.

Their aim was to destroy both food crops and all other vegetation so as to starve the rural and mountain population, and entice them into strategic hamlets set up by the US and the Saigon administration with the food available there, and later herd them into towns according to a plan of forced urbanization. Their ultimate goal was to deny the patriotic forces the natural and human cover essential to their guerrilla activities. Toxic chemical spraying was followed by the spreading of toxic gases, including CS (orthochlorobenzalmalononitrile) which was blown by Mity Mites into underground shelters, caves and tunnels to kill members of the resistance and their supporters. This very serious crime is the third large-scale contravention of the prohibition of chemical weapons by the 1925 Geneva Protocol. The first was Mussolini's troops' annihilation of the crack Ethiopian combat units in a four-day gas attack near Makale in January 1936. The second was the Japanese army's gas shelling of the Chinese garrison at the town of Yichang on the Yangzi River in October 1941.

But the US imperialists outdid both the Italian and Japanese fascists both in scale and duration as well as in the means used. Yet they claim that

this was a "clean war", because it was not bloody. The label "defoliant", for instance, was a semantic trick; but when the disastrous effects of their use on the environment become known, people were alerted to the ecocide in progress. Little by little it became clear that not only fauna and flora were being affected. In 1966, when defoliation operations were being stepped up, a sharp increase in birth defects at the Pediatric Hospital in Saigon was noted. In 1969 the Saigon press shocked the public with reports of many molar pregnancies and of malformed babies born to healthy peasants in defoliated areas. To its total war the United States had added chemical war, and this used fifteen million tons of explosives alone — the equivalent of 750 bombs of the type dropped on Hiroshima. Scientists accused the White House and the Pentagon of both genocide and biocide against Vietnam.

As early as 1966, 5,000 American scientists, among them 17 Nobel prize-winners and 127 members of the New York Academy of Sciences protested against the use of phytotoxic products in Vietnam. In 1969 liberal members of Congress followed suit, not only condemning the chemical warfare in Vietnam, but also launching a campaign against experimentation and production

of chemical and biological weapons in the United States. Vietnamese scientists, for their part, waited until 1970 to denounce the present and future devastating effects of US herbicides and defoliants on the environment. The Orsay Conference held at the end of that year drew public attention to the grave danger posed by this kind of warfare to both present and future generations. Washington's defence was that all this was just "anti-American propaganda".

For some years now we have been watching the second act of the drama, not only in Vietnam, but also in the United States and elsewhere. A great number of GIs from Vietnam have suffered from nervous tension, inability to concentrate, and nervous troubles. As early as in 1973, there was public concern in the US that there might be some relationship between these neuromental afflictions and the patient's previous exposure to herbicides. The suspicions, far from being allayed, have been roused further by more frequent cases of cancer among Vietnam veterans, miscarriages and stillbirths among their wives, and birth defects in their children caused by chromosomal aberrations. According to the American press, the US Department of Veterans Affairs (VA) has received many claims for diseases and infirmities caused by Agent Orange. American war veterans

have even set up an Agent Orange Victims International (AOVI) which intends to sue five US companies producing the herbicides during the war — Dow Chemicals, Hercules, Diamond Shamrock, Monsato and North American Phillips.

The American public's concern about the delayed-action effects of Agent Orange and particularly that of dioxin which contains Agent Orange, is shared in Australia which once sent over 70,000 men to fight beside the US forces against Vietnamese patriots. According to The Sun *(12 Jan. 1980) more than 500 Australian war veterans and their children have claimed damages for diseases and deformities caused by Agent Orange, and known Agent Orange victims in Australia number about 2,000. Public pressure has led the Australian Government to promise to investigate this sensitive matter. Meanwhile, there are numerous other "Vietnam veterans" now living in New Zealand, South Korea, Thailand and the Philippines. What have their governments done for them and their families?*

Vietnam, however, remain the main, most seriously affected, victim of the US chemical warfare. Nevertheless Vietnamese Agent Orange victims willingly unite with former aggressors who, like themselves, have become victims of this biocidal poison,

and join the latter in claiming damages and urging complete prohibition of this lethal weapon.

It is our hope that this booklet will shed more light on the problems of Agent Orange which have so worried the world public in recent years.

Hanoi, August 1980
VIETNAM COURIER

THE UNFORESEEABLE CONSEQUENCES OF U.S. CHEMICAL WARFARE IN VIETNAM

Interview with
Prof. TON THAT TUNG

Vu Can — "For many of the Americans who fought in it, the Vietnam war may not be over. More than ten years after the event, the use of chemical defoliants upon millions of areas of Vietnamese countryside is alleged to be bringing death and destruction to thousands of young Americans who thought they were survivors". This comment is not ours, but comes from the British paper *The Observer* of 24 February 1980. Earlier, the *Illinois Times* of 19 April 1979 had published an article "A killer comes home! Bodies of Vietnam veterans may harbour a sinister enemy". This killer is in fact the dioxin present in Agent Orange, sprayed by the US Air Force in Vietnam during the

years 1960 – 1971 along with Agent White and Agent Blue.

Your fame in the medical field, Professor, has spread outside Vietnam. You led the Vietnamese delegation to the Orsay Conference in 1970, which gathered scientists from all over the world to discuss US chemical warfare in Vietnam. You have published your own works and ones undertaken with other researchers, on the long-term effects of dioxin on the human body. In 1976, when about three pounds of dioxin fell accidentally in the Seveso area, the Italian Government intended to invite you to come and help them organize the relief work. During your trip to the United States in April 1979, your lectures on the cancer-causing effects of dioxin drew particular attention. Today public opinion in various countries, especially the US and Australia, is worried and is demanding an investigation. Would you please explain to our readers what dioxin is and what effect it has on the environment and living organisms.

Professor Ton That Tung – Dioxin is an impurity which is always to be found in 2,4,5 trichlorophenoxyacetic acid. This substance, 2,4,5-T, mixed with another, 2,4-D, made up the defoliant Agent Orange. Dioxin is a highly

toxic substance which when given to animals in experiments caused necrosis of the liver, fœtal deaths, miscarriages, chromosome damage, congenital defects and cancer. In the past, this substance was not given much attention, as it was believed harmless at concentrations less than one part per million (1 p.p.m. or 1.1000,000, i.e. one gramme per ton). But later it was noticed that it could be harmful at even a thousandth of that concentration (one part per trillion, 1 p.p.t.).

It should be pointed out straightaway that the defoliants 2,4,5-T and 2,4-D which were used in enormous quantities during the Vietnam war are in themselves a danger to the environment and to life. Professor Epstein believes that 2,4–D and 2,4,5–T are themselves cancer-causing. Although in theory these two substances are broken down by micro-organisms in the soil in two to fifteen weeks, the same is not true for dioxin. It is not soluble in water, but only in alcohol and fats. It can only be destroyed at a temperature of 800°C. It can remain for a very long time in nature, twenty years, in a water environment according to some writers. The most dangerous thing is that it does not stay put, but is transported by water down to the sea. The greater the quantity

of Agent Orange sprayed, the more dioxin accumulates in the environment and in organisms. While in the US agricultural sprayings are made every ten years, in Vietnam the sprayings were massive ones, carried out daily in a certain zone. In 1970 in South Vietnam, dioxin was discovered in fish from the Saigon River.

Vu Can – The memorandum of the Vietnamese Ministry of Foreign Affairs published on 21 January 1980 points out that during their war of aggression against Vietnam, Laos and Kampuchea, as well as bombs and all sorts of armaments, the Americans used toxic chemicals and gases systematically and on a large scale. In South Vietnam alone they spread more than 100,000 tons, over nearly all the provinces. About 13,000 square kilometres of cultivated land and 25,000 square kilometres of forests were touched: 43 per cent and 44 per cent respectively of the total area. And much of this land was sprayed more than once. These products destroyed 70 per cent of the coconut groves, 60 per cent of the rubber plantations, 110,000 hectares of coastal filao forest, 150,000 hectares of mangroves, and crops enough to feed millions of people. Out of two million Vietnamese people contaminated with

these products, 3,500 deaths have been officially registered. In his report of August 1970 to the US Senate, Senator Gaylord A. Nelson admitted that: "The US has dumped (on southern Vietnam) a quantity of toxic chemicals amounting to six pounds per head of population including men, women and children." This was confirmed by the Foreign Relations Department of the Library of Congress on 30 June 1971. Biology professor Arthur W. Galstone, giving evidence at a public Congress hearing on 9 February 1977, declared: "I believe that the results of damage done to Vietnam and to the environment on which all that civilization depends is still inadequately calculated. But all these observations on the American crime of ecocide were made from afar. You have studied the effects on the spot: could you let us know your conclusions as to the consequences on the present and future generations of Vietnam? Can the effects be eliminated or limited in any way? And what measures will it be necessary to take?

Professor Ton That Tung – Firstly, there's the destruction of the environment. One of my colleagues has just made a trip together with a Vietnam Television reporter to Tay Ninh and Rung Sat, which are regions affected by

American defoliants. Some very expressive photos were taken. Look at these ones. These trees were contaminated ten years ago. Now they have not a single leaf, they're dead, completely hollow.

On several occasions I have talked of the cancer-causing effects of dioxin. To tell the truth, we have not enough money or equipment to carry out exhaustive research on the epidemiology of liver cancer in both North and South Vietnam. We would have to prove that dioxin persists in the environment and in human tissues. In fact even in the USA there are only two laboratories capable of testing for dioxin in doses of 1 p.p.t. We are appealing to the conscience of Americans to ask them to help us assess and limit the damage inflicted on Vietnam.

To give you an idea of the scale of work needed, I can quote Professor Westing who estimated the quantity of dioxin sprayed on Vietnam at 550kg, while a dose of a few thousand millionths of a gramme is already harmful.

Vu Can — Before the Orsay Conference and in the following years, public opinion was mainly concerned about the immediate victim — Vietnam. For humanitarian reasons, but

also out of sympathy for our people's legitimate resistance war and sacrifices. Even at that time some people were equally concerned about the danger of these products for US Air Force members involved in the chemical warfare. But it's only today that the Americans are noticing the price they will have to pay for their government's crime of ecocide. It's already a terrible price but it threatens to prove even greater. According to the American press, by February 1980, the Veteran Administration had received at least 5,000 claims for sickness and disablement caused by Agent Orange. Many of the plaintiffs were already receiving a disablement pension. Investigations in the US seem to show that not only have the units directly involved in spraying been contaminated, but that all the GIs who fought in Vietnam could have been affected as well. One soldier told the press: "The aircrew could go back to base after a flying mission and take a shower. We didn't change our clothes for days, and drank from streams which had been contaminated by the chemicals."

Former GIs are starting court proceedings against the firms who produced Agent Orange and against the American government. They have founded an organization "Agent Orange

Victims International" whose membership is growing fast. Their president Frank McCarthy has drawn up a list of the many returning veterans who were contaminated. He has also met affected Australian soldiers. "In twelve years of combat in Vietnam," he declared, "the US had 57,002 men killed. We believe there are as many veterans suffering from chronic toxicity as the result of exposure to Agent Orange, plus about 350,000 with minor symptoms. There are 5,000 cases of cancer alone." And the US Veterans Association estimates that 1.2 million GIs were exposed to dioxin in Vietnam. All this may explain why the American government, Dow Chemicals and other firms, after having tried to deny their responsibility, are now putting the blame on each other. It must be significant that on 7 January the Australian government had to yield to public pressure and promise to make an enquiry into the eventual effects of the toxic chemicals on the offspring of Australian Vietnam veterans. What about the South Korean and Thai troops, and mercenaries from other US satellites, who must have been affected? But about the effects of the chemical warfare in America itself—what is your opinion after your recent trip there?

Professor Ton That Tung—In 1970 when Vietnamese doctors first brought up the question of the dangers of 2,4,5-T and 2,4-D and especially of dioxin for the environment and living things, many scientists who attended the conference maintained that the allegations were unscientific or just anti-American propaganda. When I visited the USA last year I gave lectures in several universities and had talk with many Americans. Many people are beginning to believe that Agent Orange is dangerous. In particular its abortifacient effect has been demonstrated in Oregon, and the EPA agency has put a temporary ban on the use of 2,4,5-T. Experiments done in the USA have shown that dioxin causes cancer and is teratogenic (deforms fœtuses) in monkeys. Today, dioxin can be considered as the most powerful cancer-causing substance in the tiniest doses.

It is true that American veterans of the Vietnam war have complained about the "delayed reaction" of the herbicides. When I got back from my visit I gathered together all the facts about the mutation-causing effects of the products. Observations were made on former soldiers who came originally from the

North and who returned from the South of Vietnam to marry northern women. A great number of congenital malformations have been noted among their children. Australian veterans have also complained of congenital malformations suffered by their children. The Australian government has ordered studies to be made of these veterans, using my clinical methods as their model.

Vu Can — So the White House is now in the grips of another scandal, the scandal of the chemical warfare's "delayed reaction". And the Carter Administration is trying to divert public concern. The American mass media have just recently launched into another slander campaign against Vietnam, accusing our country of using toxic chemicals against the remnants of the Khmer Rouge army. Beijing immediately follows suit. However the Chinese aggressors, in their attack in Vietnam of February 1979, didn't hesitate to use poison gases against our people and army. We have proof of these crimes. Since the overthrow of the Pol Pot — Ieng Sary — Khieu Samphan regime, *Vietnam Courier* has sent reporters to different parts of Kampuchea. From the information we have received, I can affirm that the Vietnamese

forces have never used toxic chemicals at any place or time. As a respected Vietnamese personality, you have had many opportunities to meet our political and military leaders. Do you believe they are people who would authorise chemical warfare, as the White House, the Pentagon and the Chinese leaders didn't hesitate to do?

Professor Ton That Tung — I don't give any credit to this lying propaganda. Let them show the proof. In 1970, when we denounced the harmful effects of herbicides, we did quote the facts, and very few Americans paid any attention. And I am convinced our leaders would never authorise such inhuman acts.

Vu Can — For some years now, the American militarists have been talking of a "clean war" including both chemical warfare and the "push-button war". The aggressor can be "clean" because there is no blood on his hands. Yet if they used bayonets and cutlasses they would cause less destruction now and for the future.

Professor Ton That Tung — A war of aggression is never clean.

Vu Can — Do you have any message for the readers of *Vietnam Courier*?

Professor Ton That Tung — Only this: all the scientists of Vietnam are making every effort to rebuild their country with very limited resources. If people of goodwill in every country will help us, we can resolve the problem of the effects of the US chemical war.

Hanoi, 15 April 1989

CLINICAL EFFECTS OF MASSIVE AND CONTINUOUS UTILIZATION OF DEFOLIANTS ON CIVILIANS

(Preliminary survey)

Prof. TON THAT TUNG, Drs TRINH KIM ANH, BACH QUOC TUYEN** DAO XUAN TRA** and NGUYEN XUAN HUYEN***

Entrusted by the DRVN General Association of Physicians with the task of inquiring about the clinical effects of the use of herbicides and defoliants on the civilian population, we have examined a group of South Vietnamese people taking refuge in the North. In that preliminary survey we have observed some most serious facts: the massive and protracted utilization of herbicides and defoliants may lead to chromosomic aberrations on people living in the

* Head of the DRVN delegation
** Members of the DRVN delegation

sprayed areas and may even provoke chromosomic aberrations with congenital malformations.

Material for study and methods of examination

Out of a total of 903 persons composed of South Vietnamese taking shelter in the North and grouped in hospitals and lodgings in Hanoi, we picked out 179 who had lived in sprayed areas for from two months to five years or who had been directly hit by the sprays :

- 90 adult men,
- 19 adult women including 4 mothers, and
- 70 children between 6 and 14.

The examination consists in recording eye-witness accounts of air sprays, estimating the number of sprays on the area, determining the initial clinical signs observed by the patients on themselves, and assessing the damage caused to men and animals. Then comes ocular, neurologic, paediatric or genetic examination.

Of course, before being questioned, all these persons have undergone a psychosomatic examination.

Results of investigation

One can distinguish :

1. a clinical table of the first after-spray hours, and
2. secondary effects.

1. Clinical table of the first after-spray hours

As soon as the area is shrouded in chemical fog, the patient feels a pricking sensation in the eyes with intense watering and rhinorrhea ; a pungent smell of chlorine or DDT suffocates him, while an intense sensation of heat similar to that of red pepper burns his nose. He sneezes unceasingly and starts vomiting while complaining of headache and intense asthenia ; this sensation recurs frequently during the examinations. All these symptoms begin to improve after 24 hours, but only after 3 or 4 days does the patient feel relieved.

Other patients suffer from œdematous swelling of the eyelids, dizziness, and a sensation of burns on the skin with phlyctena.

Here is the table of symptoms :

(See Table I on page 28)

In a word, the initial clinical signs are oculonasal signs followed by headache and vomiting accompanied by a feeling of sickness, of intense asthenia which can last 3 or 4 months with continual watering of the eyes. This asthenia remains the keynote in the months following the aggression.

TABLE I

Symptoms observed by patients at time of spraying	Patients feeling these symptoms	Percentage
Sensation of heat in nose, rhinorrhea, sneezing.....	163	91
Vomiting, sometimes with diarahoea.....	130	73
Sensation of burns in the eyes, watering of the eyes sometimes with oedema of the eyelids.....	130	73
Headache, asthenia.....	125	70
Sensation of burns on the skin, sometimes with erythema and phlyctena.....	73	41
Tachycardia, sometimes with dizziness or fainting	68	38

2. Secondary Effects

The secondary effects are classified into 3 syndromes:

- a syndrome of prolonged asthenia,
- an ocular syndrome, and
- a genetic syndrome.

a. SYNDROME OF PROLONGED ASTHENIA: 31 out of 109 adults complain of general asthenia: some remained in bed for two or

three months, later were incapable of any prolonged effort. To this asthenia, are added insomnia, headache, often sexual impotence, and menstrual troubles (for women).

A mitigated form of that asthenia is visual asthenia which affects 81% of the victims of the sprays. Reading provides a very interesting test. In the beginning, reading seems to be easy; but quickly the patient complains of indistinct vision then of eye strain: he gives up. Out of 43 persons submitted to this test, 23 could read no more than 5 minutes, 9 up to 15 minutes, and only 7 up to 30 minutes When the eyes are tired, the letters widen, the lines are superposed: if the patient tries to go on, his eyes will water and he complains of tension in the eyes and a headache. A 5—10 minutes' rest enables him to resume reading but within the same limits.

In its most serious form, it shows the clinical table of a true Addison's disease: clinical examination reveals nothing except an extreme adynamia. Only the examination of chromosomes has made it possible to attribute it to a serious poisoning by defoliants.

Observation I: Profound asthenia in a patient having lived three years in the affected area:

marked anomalies of chromosomes in culture of leucocytes.

Tran Thi Tr... 47, undergoing treatment at Hospital E for serious neurasthenia.

Antecedents: Nothing unusual in her family, except that she lived from 1966 to 1968 in a region subjected to daily sprays of defoliants; furthermore she was seriously poisoned by gases (CS probably) on three occasions while taking refuge in an underground shelter to escape from sweeps.

Chronic malaria.

Examination shows a state of extreme adynamia; the patient speaks rarely, and then in a low voice; her movements are slow; for months lies in her bed. She answers questions clearly and correctly.

Blood pressure: 110/80; pulse: 80/m, respiration: 25/m.

Nothing unusual on examination of the heart, lungs and abdomen.

The patient rarely moves her right limbs but shows no muscular atrophy. Reflexes: normal.

Examination of the nervous system: strictly negative. *Laboratory examination:*

Quantitative analysis of 17 cetosteroids: 3.31 mg/24 hours (Feb. 20, 1970)

Blood urea: 0.40 g/L

N.C.: 3,800,000 R.C., 7,000 W.C.

Hemoglobin: 70%

L.F. neutro: 59

eosino: 3

lympho: 36

mono: 2

Bordet Wassermann: negative.

Culture of leucocytes (72h.): rate of chromosomic anomalies: 7.6% (1.14% for check samples).

b. OCULAR SYNDROME: We have remarked the following lesions:

– *Visual Asthenia* (see above);

– Diminution of visual keenness: visual keenness is under 10/10 in 51 out of 60 patients examined (78.4%) compared with only 26.4% in the check group of South Vietnamese.

Ocular lesions: biomicroscopic examination of the cornea reveals cicatricial lesions of the cornea in a very large proportion: 24.6% of the eyes of 65 persons examined. Have been detected:

– superficial scars in the limbic region, chiefly in the lower and lateral sectors of the cornea (10 cases);

– scars in the central part of the cornea (10 cases);

– 7 pseudo-pterygiums;

– 1 ectasia of the cornea.

Ophthalmologic examination has made it possible to discover the following:

– optic neuritis . . . . . 1 case
– retrobulbous optic neuritis . . . 1 case
– cataract . . . . . 2 cases
– opacification of the vitreous humour 2 cases
– macular degeneracy . . . . . 1 case

c. GENETIC SYNDROME

It consists in:

– Chromosomic alterations in seriously affected adults;

– Congenital malformations of a known type, practically Trisomy 21;

– Unclassable multiple congenital malformations with multiple chromosomic alterations.

1. CHROMOSOMIC ALTERATIONS IN SERIOUSLY AFFECTED ADULTS

Here is the preliminary observation which put us on the trail of chromosomic alterations: in a little girl born with many malformations

(see observation 4) not belonging to any known type, the culture of leucocytes has revealed neither polyploidy nor aneuploidy, but most serious chromosomic alterations also found in the culture of leucocytes of the mother. We have then collected the blood of 3 groups of persons:

– a group of 6 persons affected with asthenia having lived 2 or 3 years in sprayed areas; their chromosomes are to be compared to those of the other 2 groups:

– a group of 5 normal North-Vietnamese;

– a group of 5 normal South-Vietnamese.

These 16 persons have been carefully examined concerning their haematologic, metabolic, medicamental and roentgenologic antecedents, so as to exclude all other causes of chromosomic alteration.

Here is the general account of the search for chromosomic anomalies:

EXAMINATION METHODS

The culture of peripheric blood has been carried out according to Lejeune's microtechnique.

Incubation: 72h at 37°C. Blocking of mitoses in metaphase with colchicine at 0.04%. The

mitoses have been selected by small magnification (X100). Every anomaly is detected and controlled by two specialists. The anomalies are counted and photographed in immersion (X 1000). Caryotypical studies have been made on photographic documents. For each patient, whose diagnosis is kept completely secret, 100 mitoses have been counted and 300 cells analysed. 1,600 cells of check samples have been analysed.

The caryotypes are drawn up according to Denver's classification (1960). The anomalies are classified into chromatidian anomalies and chromosomic anomalies. Also counted as chromosomic breaks are rings, dicentrics, fragments and translocations. The anomalies—ring, exchange, translocation — are multiplied by two. Suspected anomalies such as telomeric fusions or unidentifiable pictures are not mentioned.

Results

Here are the results: for 1,500 cells of the check samples, there is an anomaly rate of 1.14 for every 100 cells: for 1,500 cells of the check samples, there is no chromosomic break and only 0.4 of chromatidian breaks per 100 cells; for 1,600 cells of spray victims examined, there

is an anomaly rate of 5.88 per 100 cells. The discrepancy in anomaly rate between the checks and the victims of chemical sprays is highly significant, $t > 2.58$ with $p < 0.01$. (See Table II).

2. CHROMOSOMIC ANOMALIES OF A KNOWN TYPE WITH CONGENITAL MALFORMATIONS

The chromosomic anomalies belong to a type known as Trisomy 21. In addition to this trisomy, there are also structural alterations: 11.66% in the first observation and 19% in the second. Among these alterations, chromosomic breaks account for 3.33 per 100 cells in both cases, which is, as we know, a sure sign of chromosomic alterations according to Dubinin (1) (1962). Bender and Gooch (2) (1962), Wong An-chi and Chou Shing-ting (3) (1964).

Observation 2: Microcephaly with decerebrate state.

Little Nguyen Thi T., a 10-month-old girl, presents a microcephaly with, since her birth, fits of contracture in extension.

Antecedents: Mrs. Tran Thi C., aged 23 and married at 22, lived two months (from March

to May 1969) in a hilly region in the province of Quang Tri - Thua Thien daily sprayed by American aircraft. One morning at 9 she witnessed a direct spray on her locality. As a white fog descended upon the trees, she felt irritations in her eyes and nose, with intense rhinorrhea and watering of the eyes; she began to vomit and felt a great lassitude. These symptoms diminished in the evening and she felt quite well 3 or 4 days later. The region in which she lived had been subjected to heavy sprays for 3 or 4 months, but only since that morning did the sprays become daily. She drank water from the stream near her house but did not eat the tubers grown in the area.

In May 1969, she escaped to North Viet Nam and on December 9, 1969, gave birth prematurely to a child weighing 2.3kg.

Upon examination, the child, now a ten-month-old girl, shows a typical microcephaly, a low forehead with normally placed but hypertrophied conchae and a rather large external auditory canal. Left hand: single transverse palmar fold, normal ditigal loops, axial triradius in the t' position on both hands (intermediary between the centre of the hand and the T position).

TABLE II
FREQUENCIES OF CHROMOSOMIC ANOMALIES IN VARIOUS GROUPS EXAMINED

	Groups	Name	Number of cells counted	Number of chromosomes				
				≤ 44	45	46	47	48 ≥
I	Check groups – Normal persons		100	2	3	95		
II	– Persons having lived in South Viet Nam but not yet victims of sprays	Hoang Thi S.	100	3	1	96		
		Hoang Thi Lo.	100	4	2	94		
		Hoang Duc A.	100	1	6	93		
III	– Victims of sprays without apparent after-effects	Vo Thi Quang	100	3	6	91		
		Pham Xuan P.	100	11	12	77		
		Hoang Thi L.	100	7	8	84	1	
IV	– Victims of sprays with important after-effects: asthenia, ocular lesions	Tran Thi Tr.	100	3	8	88		
		Dinh Hong M.	100	3	5	92		
		Nguyen Van O.	150	3	8	87	2	
V	– Children born of mothers victims of sprays	Doan Thi Thu T.	100	4	6	21	69	
		Nguyen Thi T.	100	3		5	89	2
		Hoang Thi H.	100	3		93	2	

Neurologic examination (October 25, 1970) by Dr Nguyen Quoc Anh. Manifest microcephaly. Decerebration attitude: opisthotonos, extension of the four limbs, crossed lower limbs. Virtually no spontaneous activity and reactivity. Only a vegetative life, and one that is unstable: noisy breathing with suprasternal draught. No typical sign of the Down disease.

Culture of leucocytes (Dr. Bach Quoc Tuyen) for 72 hours according to the Lejeune technique.

Characteristic Trisomy 21 with mosaic 46, 47; predominance 47.

Chromosomic anomalies; 11.66% of the cells (see Table III).

Observation 3: Typical Trisomy 21 in a 3-year-old child born in a sprayed area.

Little Hoang Thi Thu Th. aged 3, was examined by us on November 2, 1970: her profile reveals trisomy 21 (bilateral epicanthus, eyes wide apart, flat nose, inverted V-shaped gaping mouth, projecting tongue).

The father was born in 1922, and the mother in 1930: the father is the eldest of a family of 5 boys and 4 girls, the mother is the younger of a family of two girls.

No alterations in the dermatoglyphics, except a single transverse palmar fold on the left with

axial triradius in the t' position; normal ditigal loops.

The examination reveals a ligamentary laxity with strongly-marked muscular hypotony in the limbs. Important psychomotor retardation. Defective phonation.

The anamnesis reveals that the father and mother lived from 1964 to 1970 in a locality of Quang Nam province subjected to daily sprays of defoliants from 1966 to 1970: personally the mother showed no sign of oculo-nasal syndrome by direct hit, but over a long period (4 years) she lived on tubers dug from the soil after the sprays and even rice hit by defoliants. The child was born in that locality on December 7, 1967.

Neuropsychic examination: (November 3, 1070) by Dr Dang Dinh Huan.

Retarded growth (0.81 metre at 34 months). Malformations of the cranio-facial mass: skull widened in the back, parietal protuberances, bregmatic fontanel still existing at 34 months.

Relatively short arms and fingers, particularly the fifth in both hands. Most conspicuous muscular hypotony: her feet can touch her head. Exaggerated laxity of articulations: the feet can be so stretched as to make the toes

touch the tibial crest. Internal strabismus to the left, Horizontal nystagmoid movements to the right. Cannot walk alone. Moves sidewise leaning on the bed.

In the psychic field: general retardation, pronounced degree of oligophreny.

Can slowly execute some simple and habitual commands: opening her mouth, sticking out her tongue, raising her arms, etc., but not more complicated ones such as handing some object over to her mother. Tends to execute movements of imitation and perseveration. Most limited faculty of speech.

Culture of lymphocytes (Dr Bach Quoc Tuyen): chromosomic alterations: 19% (see Table III).

3. MULTIPLE CONGENITAL MALFORMATIONS WITH CHROMOSOMIC ALTERATIONS ON THE CHILD AND THE MOTHER

The following observation is most interesting: a 17-month-old girl shows many malformations: visible lumps on the forehead, occipital flat part, bilateral stricture of lacrymo-nasal ducts, flat-ended thumb, valgus feet, supernumerary

toe in syndactylism with the 5th left toe. The culture of leucocytes reveals important strutural alterations also found in the mother but not in the child's brother and sister who were born before the spray and have been living far from that area.

Observation 4: Multiple malformations and chromosomic anomalies.

Little Hoang Thi H., a 17-month-old girl, was examined on October 20, 1970, for many deformations: exaggerated lumps on the forehead, occipital flat part, malformation of external ears; in both thumbs, the second phalanx is flat-ended, valgus feet with relatively long toes, the second toe is short and the fifth left toe thick and bifid. The appearance of a suppurative dacryocystitis 15 days and 3 months after birth has made it possible to discover a bilateral congenital stricture of the lacrymo-nasal ducts.

Antecedents: the mother, 38, was married at 19: she had two normal healthy children: a boy, now 15, and a daughter, now 17. She lived for one year in an area on the border of Quang Tri province (north of Cam Lo): this area was first subjected to sporadic sprays of defoliants, about once every two months; but in the second half

TABLE III

FREQUENCIES OF CHROMOSOMIC ANOMALIES IN VARIOUS GROUPS EXAMINED

Groups	NAMES	Number of cells examined	Chromatidian anomalies						Chromosomic anomalies					Chromatidian break %	Chromosomic break %	P1	% abnormal cells	P2
			Exchange	Break	Deletion	Lacuna	Dicentric	Ring	Fragment	Deletion	Break	Lacuna	Exchange					
(Normal) I	N.V.N Normal persons	1,000		4		8						2		0.4	0		1.4	1.14%
II	H.T.S. (♀)	200				2												
	H.T.L. (♂)	100												0			0.6	
	H.D.A. (♀)	200										1						
III	V.T.Q.H.	300		7	1	3								2.66	0		3.66	= 0.05
	P.X.P.	200		4	1	6			1			1		2.6	0.5	= 0.05	6.5	< 0.01
	H.T.L.	300		8	2	8					3	1		3.33	1.0	< 0.05	7.33	< 0.01
IV	Tr.T.Tr	300		4	1	12	1		1		1		1	1.66	2.0	< 0.05	7.66	< 0.01
	D.H.M.	200		2		3					1			1.00	0.5	> 0.05	3.00	> 0.05
	N.V.C	300		6	1	10			1		2	1		2.33	1.0	= 0.05	7.00	< 0. 01
V	H.T.H.	300		15		13			9		1	1		5.00	3.33	< 0.01	13.0	< 0.01
	H.T.T.T.	300		21		17			5		5	9		7.00	3.33	< 0.01	19.0	< 0.01
	N.T.T.	300		8		12			2	5	3	5		2.65	3.33	< 0.01	11.66	< 0.01

of the year, the sprays were intensified to the rate of one to three times a day. She was twice directly hit by sprays, with the already mentioned symptoms of oculo-nasal irritation; she even noticed the loss of part of her hair after each spray. She drank water from the stream in the area all year round. She did not suffer from rubeole during her third pregnancy.

Dermatoglyphics: nothing abnormal.

Radiography of the left foot (by Dr Hoang Su): supernumerary 6th toe in syndactylism with the 5th toe.

Neurologic examination (by Dr Nguyen Quoc Anh): considerable retardation of psychomotor development at 17 months. Slight ptosis. Upward sight limited with tendeney to the so-called "sunset" aspect.

Culture of leucocytes (Dr Bach Quoc Tuyen): many chromosomic anomalies: 13 % (see Table III).

Culture of leucocytes of the mother reveals the same chromosomic alterations: 7.33% (see Table III).

The caryotype of that child's brother and sister, born before the sprays were started and living far from the sprayed area, is absolutely normal.

DISCUSSION

The following four questions must be answered:

1. Can such defoliants, as 2,4,5-T provoke ocular lesions?

2. Can defoliants provoke a syndrome of prolonged asthenia?

3. Can defoliants provoke congenital anomalies?

4. Can defoliants provoke chromosomic alterations?

DEFOLIANTS AND OCULAR LESIONS

Clinically, lesions of the anterior segment of the eyeballs (lesions of the cornea) are seen on the examined persons at an abnormally high rate; all these persons have mentioned the signs on the oculo-nasal table relating to the first stage of the spray. As these lesions appear as the result of small drops of defoliants condensed on the conjunctiva and cornea, we have made ocular instillations on animals. Experimentally, on the eyes of rabbits, one of us (4) has reproduced the clinical lesions observed on man by instillations of Selest (mixture of 2,4-D and 2,4,5-T) and Tordon 22 K (4. amine, 3.5.6 picolinic acid):

a) Selest provokes on the cornea and conjunctiva 2nd-and 3rd-degree burns which may heal; but it can also cause 3rd-and 4th-degree burns (Poliak classification) resulting in opacifications of the cornea, perforations of the cornea or ocular atrophies.

b) Tordon 22 K provokes on the cornea and conjunctiva of the rabbit 2nd-and 3rd-degree burns of lesser gravity but on a larger area.

DEFOLIANTS AND ASTHENIC SYNDROMES

Can the queer and prolonged asthenic syndrome which has puzzled us so much be attributed to defoliants?

Let us recall first that this asthenia has been observed on workers in factories turning out 2,4,5-T (5). By 1960, the Dow Company was obliged to close its branches in Michigan because 60 of its workers had caught a disease characterized by cutaneous eruptions and disorders of the nervous system: chronic tiredness, lassitude and depression. Workers of another firm in New Jersey showed similar symptoms, but that asthenia could still be observed on some workers *six years later*. Since 1960, West

German physicians have noted the same disease on workersh andling 2,4,5 — T together with liver complaint, mental and nervous disorders, depression, loss of weight and appetite and sexual impotence.

Let us also recall that the LD 50 Rat lethal dose (dose in kg/weight, capable of killing half of the experimental rats) is about 400 mg. for 2,4,5 — T. According to Drill and Hiratzka (6) (1953), the absorption of strong doses of that product provokes muscular lesions in dogs.

We can come to the conclusion that rather than a massive intoxication, a slow intoxication of the human body drinking water containing 2,4,5 — T from continual sprays can lead to a prolonged asthenia. On such patients, we can detect another stigma pointing to the initial disease: chromosomic alteration on culture of leucocytes (see Table II).

DEFOLIANTS AND TERATOGENIC AGENTS

1 — 2,4,5—T and dioxin

The defoliants and herbicides used in South Viet Nam are of various kinds but the attention of the medical world is particularly focused

on 2,4,5−T of which 40 million pounds have been sprayed on 5 million acres, in 9 years, according to Jackie Verrett (7).

2,4,5−T, or 2,4,5-trichlorophenoxyacetic acid, differs from 2,4-D with which it is frequently associated, by a complementary atom of chlorine: most of the time, these two products are found in formulae derived from kerosene or diesel oil. Esters of 2,4-D and 2,4,5-T are the active elements of Agent Orange used in Viet Nam.

The first known report on the teratogenic effects of 2,4,5-T is that of the *Bionetics Research Laboratories* (8). The following was reported:

2,4,5-T is given through the mouth to BL6 mice in 46.6 and 113mg/kg doses and to AKR mice in 113mg/kg; it is also given to BL6 mice in 21.5 mg and 113mg/kg doses and to AKR mice as well as to BL6AK hybrids in 113mg/kg doses, by sub-cutaneous injections. The administering of the drug is carried out for 8 days in most cases (from the 6th to the 14th day of gestation); for 9 days in some cases (from the 6th to the 15th day) and for 5 days (from the 10th to the 14th day) in one case. The sub-cutaneous method utilizes DMSO as vehicle, and the oral method, honey.

Except the lowest (21.5mg/kg given to BL6 mice by the sub-cutaneous method) *all doses, whatever the method used, provoke a high incidence of abnormal foetuses.* The appearance of a palatine division is very frequent with a 113mg/kg dose, but nil with weaker doses. The appearance rate of kystic kidneys is also high, except for the AKR stock and BL6 mice which receive 46.4 mg/kg through the mouth. Foetal mortality goes up in all the groups receiving 113mg/kg for 8 or 9 days, except for the BL6 mouse which receives a weaker dose (46.4mg/kg through the mouth and 21.5mg/kg by sub-cutaneous injection).

A similar study was made by American authors on rats of the Sprague-Dawley stock. With doses of 21.5 and 46.4mg/kg in suspension in 50% of honey, and given through the mouth from the 6th to the 15th day of gestation, one observes an excessive foetal mortality rate and a high incidence of malformations in the survivors. A remarkable fact: with the weakest dose (4.6 mg/kg) and the shortest time of injection, the incidence of abnormal foetuses is three times greater in experimental animals than in check animals.

As 2,4,5-T is mixed with such impurities as *dioxins*, the latter have also been studied. At

the FDA conference (February 24, 1970), it was found that with a dose of dioxins of 9.1mg/kg day, on hamsters in gestation, foetal mortality was 82% and foetal anomalies 82%. With 0.5mg/kg doses, the incidence of anomalies was 5% (9).

Besides, with purified 2,4,5-T, its teratogenic effects have been confirmed on Swiss Webster mice and on hamsters by the *NIEHS Studies* and the *FDA Studies*.

II — Contamination channel and minimum teratogenic dose

By what channel is the pregnant woman contaminated and what dose leads to teratogenic effects?

It seems that people are intoxicated not by direct hits (through lacrymo-nasal ducts, respiratory ducts) but rather through the water of streams polluted by continued sprays.

Besides, it should be pointed out that 2,4,5-T can persist in the soil for a certain time: Miller and Berg (11) affirm that in doses of from 0.25 to 8 lbs per acre, it can remain for 4 or 5 months; De Rose (12) puts the maximum at 6 months.

Whiteside (13) has reckoned that with the per acre dose used in Viet Nam, a Vietnamese woman of 40 kg who drinks 2 litres of contaminated water per day absorbs in this way 120 mg of 2,4,5-T or 3 mg per kilogram of her weight. With 2,4,5-T polluted by dioxins, which is the rule, the rate of dioxins absorbed is 1/10 of microgram per day.

Can such a dose be teratogenic? One knows that it is difficult to transpose doses observed in experimental animals to man. Experimentation with thalidomide has made it possible to compare the sensitiveness of the human race with that of animals. With thalidomide, the lowest teratogenic dose is estimated at 0.5mg/kg/day. For the same action, that dose is estimated at:

30 mg for a mouse
50 mg for a rat
100 mg for a dog
350 mg for a hamster (Kalter) (14).

It can be said that a woman's sensitiveness to teratogenic effects is:

60 times that of a mouse
100 times that of a rat
200 times that of a dog
700 times that of a hamster.

By supposing that a woman is as sensitive to 2,4,5-T as to thalidomide (which is very possible), one can try to calculate the minimum teratogenic dose in her, knowing that she is 100 times more sensitive to this effect than the rat : the weakest teratogenic dose being 4.6mg/kg in experiments on rats of the Sprague-Dowly stock, the minimum teratogenic dose for women would be approximately 4.6 : 100=0.046 mg/kg.

According to Whiteside, the dose taken by a Vietnamese woman of 40 kg drinking polluted water is 3 mg/kg, that is 64 times the supposed teratogenic dose. If the sprays are made daily on a region, the chances are extremely great for a young pregnant woman to conceive an abnormal foetus.

Now, suppose dioxins are responsible for teratogenic effects : as the woman absorbs one-tenth of a microgram per day through polluted water (Whiteside), this drug would accumulate in the body just like any other chlorine hydrocarbons and finally reach the teratogenic threshold ; as the sprays are made daily, there are great chances for her to give birth to an abnormal child.

Thus, for a dose of defoliant to become teratogenic, it must reach a limit which cannot

as yet be accurately determined as with thalidomide, but one can reach this limit :

a) either by a marked susceptibility of the human body to 2,4,5-T or to dioxins ;

b) or by utilization of massive doses ;

c) or by accumulation in the body.

III — Value of experiments on aminals in teratogenic tests.

One of the biggest difficulties lies in the fact that sensitiveness to a teratogenic drug varies from one species to another, for instance, thalidomide is dangerous for rabbits but causes no malformation in rats. Nevertheless, if experimentation is positive on several species, at least on three of them, particular attention should be paid, especially when these are rodents : for one knows that there is no fundamental difference between the reaction of the human embryo and that of the embryo of rodents (15).

IV—Foeticide action in women

Here, clinical tests can be decisive. One can observe :

1. *An abortive action* : The examination of victims of sprays has revealed disturbing facts which should draw the attention of medical

circles to the susceptibility of the human genetic material to some defoliants:

a) In the days following the sprays there was an abnormal number of miscarriages: for instance, in the districts of Long Dien and An Trach (Central Trung Bo), among the 73 women having shown signs of oculo-nasal injury, there were 22 miscarriages (May 1966).

b) Cases of slinking were observed in domestic animals:

- in the district of An Nghia (Central Trung Bo), after a spray (in March 1966), 7 cows cast their calves prematurely; in the same district, all the hens ceased laying eggs after the spray;

- in the district of Long Dien and An Trach, after a spray in May 1966, 63 cow-buffaloes and 92 sows slunk their young ones.

2. *A growing frequency of molar miscarriages:* in the sprayed areas, an abnormal frequency of molar abortion has been reported. This is disquieting if we recall that the placenta of triploids shows even macroscopically in most cases a vesicular, subnolar aspect affecting part of or all the villosities (Philippe and Boué) (16). A chromosomic aberration by ingestion of 2,4,5-T at the beginning of gestation can be at the origin of these molar miscarriages.

DEFOLIANTS AND TRISOMY 21

Of four women delivered, we have observed two cases of trisomy 21 in two South Vietnamese women having lived in affected zones: one of them has even shown immediate signs of oculo-nasal injury after one of the sprays.

One knows that trisomy 21 is the consequence of an error in the separation of homologous chromosomes attributed to the mother's ageing. However, that trisomy can also be the consequence of radiation or toxic drugs and one knows that the noxious product can act on the organogenesis between the second and seventh week of gestation.

Here are the anomalies we have observed in the examination of our trisomic cases.

1. The youth of the mother in the first case: it is known that trisomy 21 affects chiefly the last-born children of large families, and consequently of aged mothers. Carter (17) and Penrose (18), Turpin and Lejeune (19) estimate that before 30, the risk is about one per 2,000; at 35 it will be 4 per 1,000 and about 2 per cent after 45. The two above-mentioned mothers were at the time of the birth of their trisomic children 22 (Observation 1) and 37 (Observation 3) years old respectively.

2. In the first case, trisomy 21 is also associated with microcephaly.

3. The two triosomic cases show no dermatoglyphic alterations on the fingers; only a unique transverse palmar fold is seen on one of the hands, in both cases.

4. The great frequency of that trisomy on such a small number of mothers. It is known that trisomy 21 occurs with a frequency ranging from 1/600 to 1/700 births, whereas in our small group, it is 2/4 births.

5. Lastly, what makes it possible to affirm that these cases of trisomy 21 derive from medicinal intoxication, is that besides that trisomy, we have detected most serious structural chromosomic anomalies in the two children, with 3.33 chromosomic breaks per 100 cells.

This means nearly 6 times more than with the survivors at Hiroshima (0.55/100 cells with chromosomic breaks, according to Bloom and Al) (20).

DEFOLIANTS AND OTHER CONGENITAL MALFORMATIONS

Observation 4 reveals the existence of many anomalies (skull, tear-duct, limbs) on a child,

associated with structural anomalies of the chromosomes also found on the mother (13% on the child and 7.33% on the mother). This enables us to suppose that mother and child have probably been victims of many chemical aggressions at the time of gestation, the embryo being more sensitive to chromosomic alterations than the adult.

DEFOLIANTS AND CHROMOSOMIC ALTERATIONS

One knows that chemical substances can provoke chromosomic aberrations. Darlington and Keller (21) (1947) were the first to depict chromosomic alterations caused by nitric mustard on *Tradescantia*, which paved the way for studies on chromosomic alterations caused by anti-cancerous medicines (22, 23, 24) and by chemical substances the list of which was drawn up by Stahl and Luciani (25). Then came the tragedy of thalidomide and the revelations on LSD 25 (26, 27, 28).

We think that we are the first to point out chromosomic aberrations caused by some defoliants used in great and repeated doses.

The alteration of chromosomes thus seems to have played a pernicious role during gestation:

1. Chromosomic alterations appear to be responsible for the many miscarriages in women and animals according to the work done by Carr (29) and recently continued by French authors: Boué J. and Boué A. (30), Philippe and Boué J. (16), Roux (31).

2. Chromosomic alterations which happen in the first constitutive cells of the embryo have caused congenital anomalies of the type mentioned in observation 4.

3. Defoliants (of the 2,4,5-T type or dioxins) are inductors of both chromosomic alterations and teratogenesis, and these facts brought to light and proved by American experiments appear to have been confirmed by our clinical observations.

What will be the future of a population facing ecological upheavals which do not even spare, just as in an atomic war, the human chromosomic patrimony? Cancer, especially leukaemia and monstrosities (13) will certainly be the most serious dangers. At present, due to the alteration of their chromosomes, there exist two populations who seem to suffer the same tragic fate: the survivors of Hiroshima

and Nagasaki and the victims of defoliant-sprayed areas in South Viet Nam.

In conclusion, though still limited in number, our clinical observations confirm the results obtained on animals by American researchers. The massive and prolonged utilization of defoliants, besides permanent ocular lesions, can cause chromosomic alterations among a population obliged to cling to ancestral soil and these alterations can provoke among their progeny congenital malformations the importance of which remains to be determined.

In the abominable history of wars, have we ever seen such an inhuman fate reserved for the survivors except in the case of atomic war?

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2,4,5 – T SPRAYED IN SOUTH VIET NAM

Protocol of chemical examination.

On July 15, 1969, at 9 a.m. three C.123 planes sprayed toxic chemicals on the western part of the district of Huong Thuy, province of Thua Thien.

These chemicals devastated 300 hectares of cropland (grain, vegetables, fruit trees).

Nearly 100 persons were poisoned with such symptoms as headache, fever, vomiting...

The toxic products, light brown in colour, fall in tiny drops and completely cover the leaves of the trees and surface of the earth.

We have taken some of these tiny drops from the leaves for analysis.

Various chemical experiments have been conducted :

1. with mercuric bromide ($HgBr_2$) reagent: negative result;

2. with chromotropic acid reagent in sulphuric medium: positive result (appearance of a purplish pink colour);

3. with the Rhodamine B reagent: positive result (appearance of a red colour),

4. by chromatography on thin layers:

– on silicagel G layer;

– with the system of solvents: chloroform, acetic acid (ratio 19 to 1);

– reference substances; ester butyl n. of 2,4-D; ester butyl n. of 2,4,5-T

– indicator: iodine vapour;

Results:

– appearance of purple spots,

– samples and reference substances have the same frontal relation.

Conclusions:

Basing ourselves on the noxious actions of the products on the trees, and on the results of laboratory analyses, we have come to the conclusion that the chemicals sprayed by American planes over Huong Thuy were butylinic n. esters of 2,4-D and 2,4,5-T.

July 20, 1969
Signed: **HUYNH VAN BA**, chemist

LONG-TERM EFFECTS OF MASSIVE USE OF DEFOLIANTS AS WAR MEANS IN VIETNAM: DIOXIN AND PRIMARY CANCER OF THE LIVER

TON THAT TUNG and BUU HOI

The long-term effects of defoliants (2,4-D and 2,4, 5-T) do not come directly from those products which are theoretically quickly metabolised by micro-organisms of the soil in 2 to 15 weeks in temperate climates (1) but from a chemical impurity of trichloro-2, 4, 5 phenoxyacetic acid. We would like to name tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin, generally called dioxin, which is recognized as a stable chemical substance.

Dioxin is a constant impurity of trichloro-2, 4, 5 phenoxyacetic acid for one can obtain

it directly from that acid through simple pyrolysis at 500-600°C (2). It is not soluble in water, it is only soluble in alcohol and in fatty matter and cannot be destroyed at the temperature of 1,000°C (3). It is estimated that one can get 30g of that substance out of a ton of 2, 4, 5-T and Westing thinks that the weight of dioxin sprayed on South Vietnam reached 550kg, which is a huge figure, for the substance is active from some micrograms (1 microgram = $1\ 10^{-6}$ g) (4).

It is a very toxic substance: it provokes hepatic necrosis through ingestion. Through local application to animals it provokes precancerous lesions: hyprolapsis of cutaneous epithelium, suppression of sebaceous glands (5).

The lethal dose LD50 of dioxin for the guinea pig, which is the animal most susceptible to the product, is 0.6 microgram/kg in the female guinea pig (6) and 0.5-1 microgram/kg in the male one.

Dioxin is teratogenic in the hamster, between the 6th and 10th day of gestation at doses oscillating between 0.5 microgram/kg/day (5% of foetal anomalies) and 9.1 microgram/kg/day (82% of anomalies).

The carcinomimetic effect of tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin has been studied by

Buu Hoi and his team who were able, on their own, to synthesize half the well-known cancerogenic bodies.

Instead of relying on the technique of producing cancer directly by animals, which was subjected to recent criticisms by L. Goldberg (10), they have used two types of chemical tests inspired from the study of chemical cancerogenics (9):

1. searching for a change of rates of 2 typical microcomic enzymes: the zoxazolamine-hydroxylase and the hydroxylase likely to make phenobarbital inactive.

2. searching for a possible effect on the biosynthesis of hepathic arginasis.

Test of zoxazolamine-hydroxylase. This test is based on the measured extent of paralysis produced in the Wistar rat by a definite dose of zoxazolamine; the carcinogenic product introduced before the zoxazolamine provokes the appearance of an enzyme of hydroxylase type which shortens this paralysis as compared to the control rats. The greater the inductive power, the shorter the paralysis (11). The inductive power of the tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin still occurs at the dose of 5 micrograms and proves at least 60 times more active than the classical carcinogen benzo (a) pyren.

What is more interesting is that only the tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin is active, whereas its other isomers (non-substituted form, nitro-2, dichloro-1, 6, dichloro-2, 7, octachloro) are not.

Test with phenobarbital. On male Swiss mice, dioxin provokes the appearance of a hydroxylase which shortens phenobarbital-induced sleep in a very significant way.

Rate of arginase in liver. On Wistar rats using dioxin, as during chemical cancerogenesis of the liver, the rate of hepathic arginase gradually decreases to a significant extent.

In conclusion, the results obtained show that tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin is susceptible, even at weak doses, to deeply perturb the enzymatic equipment of the organism as do typical cancerogenic substances such as benzo (a)-pyren and the p-dimethylaminoazobenzine. Those perturbations are probably partial, and are at the root of the extraordinary toxicity delay of that substance.

Those comparisons led Buu Hoi and his team to study the power of dioxin as an enzyme-inducing agent (12), of the cascade type, comprising a whole series of bio-chemical lesions. Thus adult Wistar rats which receive intraperitonal injections of a simple dose of 10mg/kg

in olive oil see their enzymes rise ten days after the injection: SGOT, SGPT, lacticodeshydrogenase, arylesterase, chominesterase.

The target organs of dioxin are in the first place the liver (13) which presents centroglobulary stasis with dissociation from Remarck traves, considerable alterations of hepatocytes and the hyperplasis of Kupffer cells on the very day after the intraperitonal injection; then comes the thymus, particularly in young animals, and finally the heart. These lesions occur even at the weak dose of 1mg/kg.

In short, experiments on animals show that tetrachloro-2, 3, 7, 8 dibenzo-p-dioxin, the only one of all its isomers, is a powerful inductor of enzymes which relate it to the more powerful known cancerogens and that it acts on the hepatic gland as its main target.

Statistical study of primitive liver cancers in Vietnam

These experimental observations lead us to study the frequency of primitive cancer in Vietnam in terms of the spraying of defoliants.

We have taken the year 1961 as a landmark, date of the first sprayings, and noted the num-

ber of liver cancers for a period of 6 months before and after that date.

We have drawn up the following figures for 4 hospitals of Hanoi:

1955—1961	159 cases out of 5,492 cancers average 26 cases per year
1962—1968	791 cases out of 7,011 cancers average 144 cases per year

$Chi^2 = 164$

$P = 1.10^{-9}$

(a highly significant difference)

Primary liver cancers have increased from 2.89% of the total number of cancers to 9.07% between those two periods, before and after 1961.

We have inquired into other possible actiologies to this explosion of primary liver cancer, for example a viral origin at present in fashion. Now, the systematic research of *antigen Au* in the blood of our patients bearers of primary liver cancer shows only a very weak positivity: 2.05%.

This recrudescence of primary liver cancer in North Vietnam, while the spraying of defoliants was mostly used in the South, can be explained by the continual mixing of populations between the two zones and perhaps—

this remains to be proved—by the transport at a distance of the toxic product by the wind or vector animals: mammals, birds, insects.

Moreover, there remains a *missing link* which, if it can be supplied, would allow us to affirm that dioxin is a chemical substance inductive of liver cancer in man: it would constitute positive proof of the presence of dioxin in the hepatic tissue of human cancers. At present, this is the most difficult research work, even in the best laboratories of the world.

Matthew Meselson, from the Department of Biochemistry and Molecular Biology of Harvard University, draws attention to the fact that there exists at present no method able to prove the presence of dioxin in the body of an animal after a lethal dose has been administered. Thus, for the guinea-pig, the LD50 lethal dose for the female was 0.6 microgram/kg of weight. That means that if all the dioxin had been retained in the dead animal, the entire rate of dioxin in its tissues would be somewhat less than 1.10^{-9} g, whereas the lowest detection limit so far reported has been 50.10^{-9} g. M. Meselson has kindly promised to help us in our research work.

In short, dioxin, which is a stable substance and a constant impurity of 2,4,5-T, seems to explain the *residual effects* of spraying defoliants: teratogenic substance very probably mutagenic in man (14), its role as a cancerogenic is clearly proved by its properties of being inductive of enzymes which ally it to the most powerful known cancerogenics. Experiments have proved that the target organ of its action is the liver and the present explosion of primary liver cancer in Vietnam can be associated with pollution of South Vietnam by the enormous mass of 550kg of dioxin mixed with defoliants used by the American army. Other studies seem to be necessary to affirm the action on man (detection of its presence in the cancerous livers for example). Nevertheless, the amount of evidence gathered by us must draw the attention of the scientific world to that product which has been massively spread on the Vietnamese ricefields and forests and whose noxious effects on man seem to go far beyond those of the known pollutants.

Surgical clinic of the Medical Faculty of Hanoi (Viet–Duc Hospital) and

Lannelongue Institute of Research on Chemical and Hormonal Cancerogenesis (92 Vanves, Hauts de Seine).

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LATEST RESEARCH ON THE PROBLEM OF MUTAGENIC EFFECTS ON THE FIRST GENERATION AFTER EXPOSURE TO HERBICIDES

We publish in this booklet the main conclusions of the latest research work by Prof. Ton That Tung and his collaborators Ton Duc Lang and Do Duc Van.

Vietnam Courier

Methodology: The researchers began by studying obstetrical statistics but unfortunately, since the fathers' military service was secret, it was not information that figured in most of the cases. They then happened to meet the head of the health service in the town of Yen Bai in Hoang Lien Son province, Doctor Mai, who was interested in their work. Yen Bai, which is twinned with a town in the South, is the home of a number of veterans who fought in the South and who, for the most part, are northerners. There were some 700 such men among a population

of 32,000, (1) working in agricultural or handicraft co-operatives in the town or its suburbs.

After Yen Bai, they surveyed groups of veterans in six provinces: Hanoi, Hai Hung, Nam Dinh, Haiphong, Thai Binh and Thanh Hoa, and conducted individual interviews.

Note that the places where the interviews took place have never been sprayed with defoliants.

Results:

A — Hospital enquiries

B — Maternity home in Yen Bai

Material: 3,058 births from 1975 to 1978 (4 years).

Number of children with deformities: 30.

Number of children with deformities whose fathers are war veterans and whose mothers have always lived in the North and never been sprayed: 15.

Of these 30 deformed children, 22 were full-term births, and 8 others premature births.

Weight:

(1) Figures provided by the Hanoi Central Statistics Service.

Less than 2.5 kilograms : 20 children
Between 2 and 2.5 kilograms : 5
Two kilograms or less : 4
Unrecorded : 1

I — Deformed children born of war veterans from the South and Yen Bai mothers:

Anencephaly : 2
Anencephaly; arhinia and left anotia; cleft lip; buffalo-neck; umbilicus near sternum : 1
Anencephaly; bulging eyes, buffalo-neck, retracted shoulders; and facial cleft : 1
Anencephaly; ascitis; stunted limbs (upper limbs: 8 centimetres) (lower limbs: 11 centimetres) : 1
Anencephaly; arhinia and anophtalmos : 1
Hydrocephalus; angulated upper limbs (with only 3 digits on right hand and 4 on left hand); without anus : 1
Arhinia; joined ear lobes; joined feet and legs; joined hands and forearms; bilateral syndactylia : 1
Ocular ectopia; joined ear lobes; clubfoot : 1
Ascitis with agenesis of upper lip : 1
One-armed : 1
Web-fingered and web-footed : 1

Polydactylism	:	1
Cleft lip and cleft palate	:	1
Defective abdominal wall	:	1
		15

II – Deformities among the civilian population (10,000):

Cleft lip	:	2
Cleft lip and cleft palate	:	1
Clubfoot	:	1
Generalized edema	:	4
Ascitis plus Fallot	:	1
Imperforated anus	:	2
Spider belly plus hermaphrodism	:	1
Hydrocephalus; ascitis; stunted limbs	:	1
Hydrocephalus; no arms at all; three digits protruding from shoulders	:	1
Hydrocephalus	:	1
		15

It is clear that there were more anencephalic cases among children of war veterans (6/15) than among children of civilian fathers (0/15).

b) Maternity Home at Quy Mong district (Yen Bai).

Material: 233 births from 1976 to 1978 for a population of 4,500, with 30 war veteran families.

Number of deformed babies	:	9
Number of deformed children of civilian fathers	:	0
Number of deformed children of war veteran fathers and Yen Bai mothers	:	9

The following deformities were found in the children of six couples:

Anencephaly; no upper jaw; stunted limbs; Spider foetal	:	1
Anencephaly	:	1
Anencephaly; cleft palate; ascitis; stunted limbs; no penis	:	1

(The above three cases were children born to a single couple). (1)

Cleft palate: death on sixth day from cyanosis (heart disease?)	:	1
Hydrocephalus; cleft lip; atrophied uvula-palatina death on third day from cyanosis (heart disease?)	:	1
Cleft lip; stunted limbs; death on sixth day	:	1

(1) Both husband and wive insist that there were no cases of anencephaly in their respective families.

One single lower limb, planted on a shapeless mass of flesh : 1

Stunted limbs; big ears; ascitis : 1

9

Dominant deformities in this group were:

Anencephaly (3/9)

Cleft lip with or without cleft palate (3/9)

Potential heart disease (3/9)

Stunted limbs (5/9)

B – Inquiries made among groups of war veterans settled in North Vietnam:

The investigators visited

I – Gia Lam (suburb of Hanoi)

II – Tu Ky (Hai Hung)

III – Kim Dong (Hai Hung)

IV – Hung Ha (Thai Binh)

V – *Chuong* My (*Ha Dong*)

VI – Haiphong

VII – Ba Dinh (Hanoi)

VIII – Nam Dinh

IX – Ninh Binh

X – Phu Ly

XI – Thanh Hoa

All told, they interviewed 1,549 war veterans. 956 (*) of these had been in areas in the South which were sprayed with defoliants (Group A). 593 others had never gone South (Group B). Of the 956 war veterans in Group A there were 786 couples in which the wives had always lived in the North, and the control group consisted of 418 couples from 593 war veterans.

Results of the investigations are contained in the following table:

(*) All the fathers of deformed children showed signs of being directly affected by defoliants in the South. Their stay in the affected areas varied between three and four years.

INQUIRIES MADE AMONG 1,549 VIETNAMESE WAR VETERANS

Group A: 956 war veterans with 786 couples in which the husbands had lived in the sprayed areas in South Vietnam.

Group B: 593 war veterans with 418 couples in which the husbands had never been in South Vietnam (control group)

Groups	Congenital malformations		Miscarriages		Premature births		Sterility	
	Number	%	Number	%	Number	%	Number	%
Group A (956 war veterans from the South, 786 of them married to women living in the North)	47 (of 1496 full-term births)	3.14	252 (of 1748 pregnancies)	14.42	30 (of 1496 births)	2.01	22 (of 786 couples)	2.80
Group B (593 war veterans not from South Vietnam, 418 of them married to women living in the North)	3 (of 1438 full-term births)	0.21	143 (of 1581 pregnancies)	9.04	9 (of 1438 births)	0.61	5 (of 418 couples)	1.20
	$P < 1.10^{-9}$		$P < 1.10^{-5}$		$P < 1.10^{-3}$		$P > 0.05$	

Normal figure for anomalies in relation to statistics of the Centres for Mother and Child Welfare of Haiphong, Hanoi and Hung Yen 1976–1979

Congenital malformations

Haiphong: 56/11,364 births 0.49%
Hanoi : 91/14,479 births 0.63%
Hung Yen: 12/3,524 births 0.34%

Characteristics of deformities:

Group A

Anencephaly:	6
Microchepalia dementia:	1
Anophthalmy:	1
Hydrocephalus:	1
Genu valgum:	4
Absence of left forearm:	1
Congenital bilateral cataract:	1
Cleft lip and cleft palate:	4
Polydactyiism:	4
Stunted, jointless upper limb:	1
Hermaphrolite:	1
Right anotia:	1
Congenital heart disease:	18
Testicular ectopia	1
Paralysis of external oculomotor muscle:	11
Mongolism:	1
	47

Prominent in this group were
1. Heart diseases: 18/47
2. Deformed neural tube: 9/47

Group B

Polydactilism 3

The normal rate should be:

– One anencephalic case in 7239 births. in Vietnam. The rate among Vietnamese veterans from the South, however, was one in 197.7.

– One microcephalic dementia in 25,000 children (*). In Vietnam, the rate among veterans from the South was one in 1,187.

– Anophtalmy would normally occur once in every 10,000 births. The rate in Vietnam was one in 1,187.

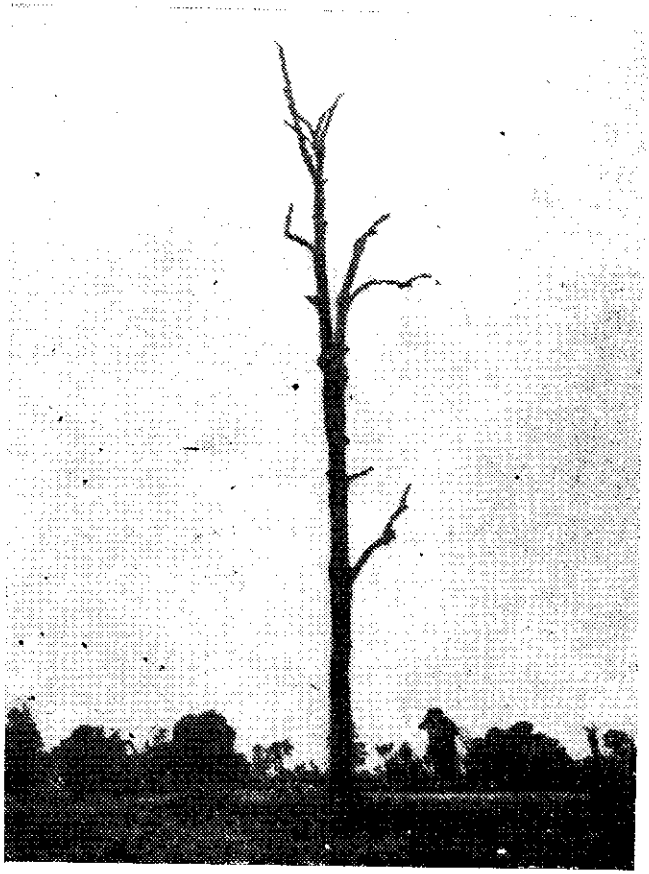
One should also note the important part played by heart deformity: 18 cases in 47 deformities.

* According to the "Report of the UN Scientific Committee on the Effects of Atomic Radiation", General Assembly Official Records, 13th Session, suppl. No. 17, (A/3838), New York 1958, Annex H, pp. 172 – 204

PERCENTAGE OF MALFORMATIONS IN RELATION TO BIRTHS AMONG THE CIVILIAN POPULATION IN VIETNAM

North (1976 – 1979)		
Hai Phong	56/11,364	0.49%
Hanoi	91/14,479	0.63%
Hung Yen	12/ 3,524	0.34%
South (1966 – 1969)		
Baria	14/ 6,056	0.23%
Nha Trang	37/11,663	0.32%
Quy Nhon	21/ 6,190	0.34%
Da Nang	37/13,061	0.28%
Hue	39/ 5,271	0.74%
Tay Ninh	10/ 6,947	0.14%
Da Lat	33/ 4,865	0.68%
Tu Du	573/98,683	0.58%
Hung Vuong 2	292/49,822	0.59%
Bien Hoa	59/18,660	0.32%
Can Tho	97/14,287	0.68%
Kien Hoa	15/12,714	0.12%
Tan An	14/12,918	0.11%
Total	1,241/261,137	0.48%

VEGETATION DESTROYED BY US TOXIC CHEMICALS IN THE SA MAT TAY NINH AREA



86

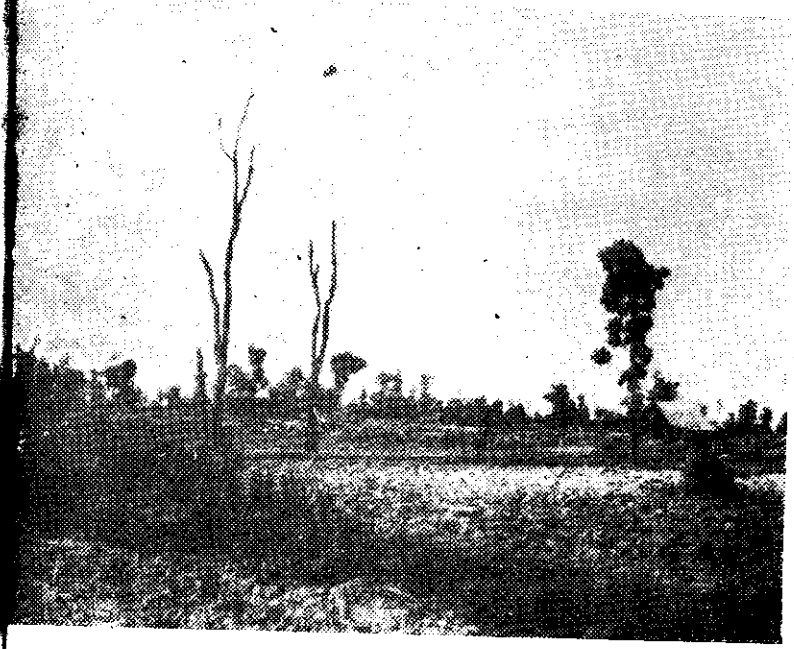
87

Timber felled from a forest sprayed with toxic chemicals.

ATTEMPTS TO RESTORE THE AREAS DAMAGED BY TOXIC CHEMICALS IN SPRING 1980

(Results are still unknown)

Building a new house.



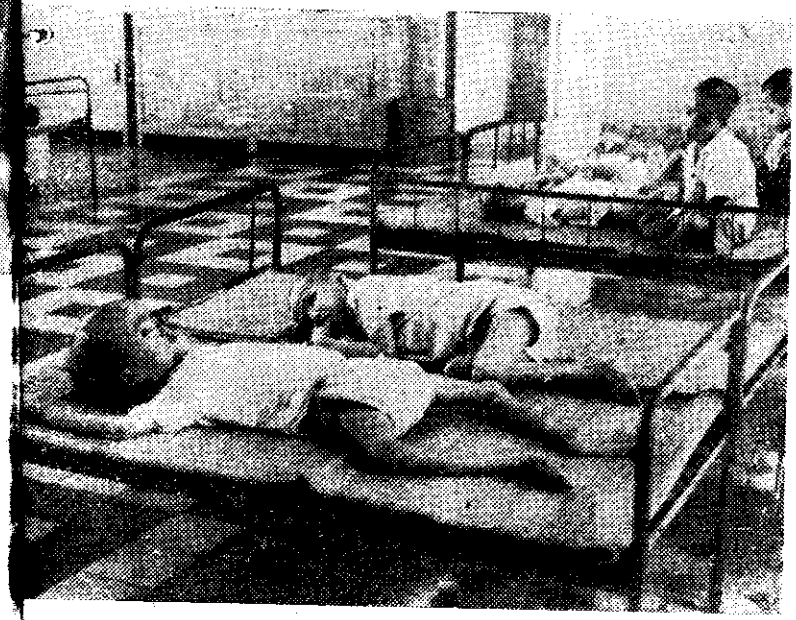
The first cassava roots.

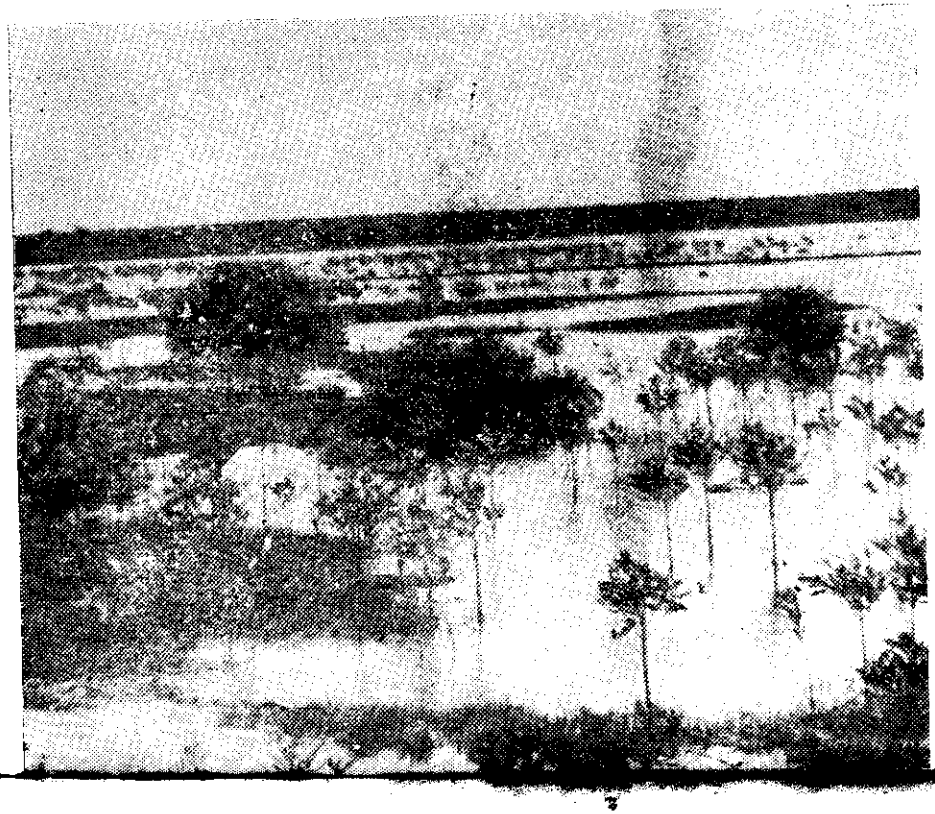
Newly - planted matze...

banana trees.

IN A HOSPITAL FOR INVALIDS IN HO CHI MINH CITY

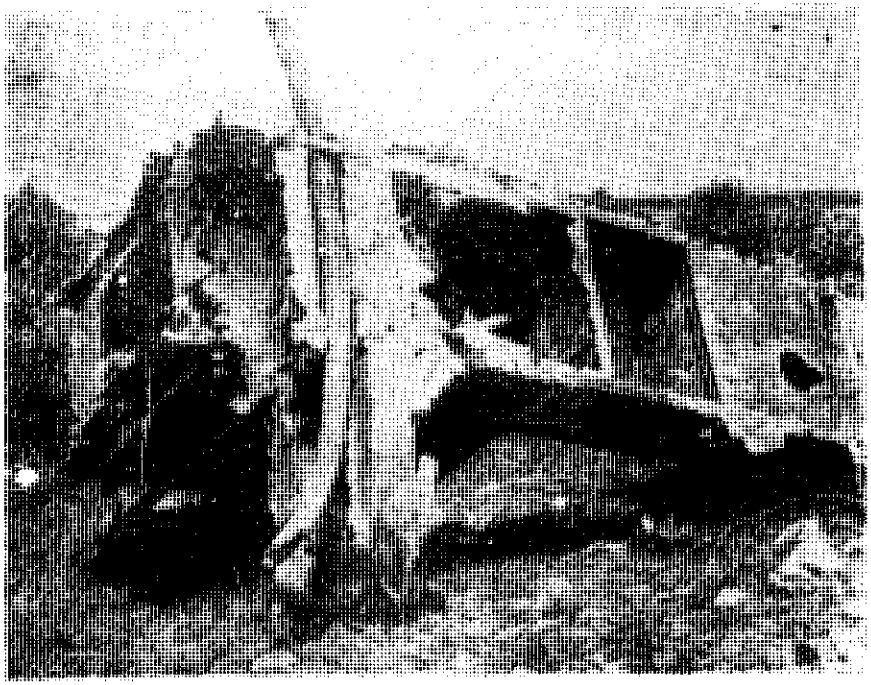
Deformed children from the sprayed areas.





All the mangroves in Vung Tau area were destroyed by toxic chemicals.

Photo : *The newly-planted mangroves after one year.*



Debrts of a helicopter used for spraying shot down by the liberation fighters.