Thirty-eighth session
Item 61 of the preliminary list*

CHEMICAL AND BACTERIOLOGICAL (BIOLOGICAL) WEAPONS

Letter dated 10 April 1983 from the Permanent Representative of Viet Nam to the United Nations addressed to the Secretary-General

I have the honour to transmit herewith the official documents of the International Symposium on Herbicides and Defoliants in War: The long-term effects on man and nature, held at Ho Chi Minh City from 14 to 19 January 1983. The documents include the Final Summary Report of the Symposium, providing background information on its subject, seven additional reports providing summaries of the following working groups of the Symposium:

1. Plant ecology and forestry
2. Animal ecology
3. Soil ecology
4. Coastal and aquatic ecology
5. Cancer and clinical epidemiology
6. Reproductive epidemiology
7. Experimental toxicology and chemistry

and an appendix entitled "List of participants".

* A/38/50.
I should be grateful if Your Excellency could arrange for this letter and the above-mentioned documents to be circulated as an official document of the General Assembly under item 61 of the preliminary list.

(Signed) HOANG BICH SON  
Permanent Representative  
of the Socialist Republic  
of Viet Nam to the United Nations
ANNEX

FINAL SUMMARY REPORT
OF THE INTERNATIONAL SYMPOSIUM ON
HERBICIDES AND DEFOLIANTS IN WAR:
THE LONG-TERM EFFECTS ON MAN
AND NATURE

(Ho Chi Minh City, 14—19 January 1983)

The "International Symposium on Herbicides and Defoliants in War: The long-term effects on Man and Nature" was held in Ho Chi Minh City from 14 to 19 January 1983.

More than 160 scientists and experts from 21 countries as well as observers of FAO, UNEP and UNESCO attended the symposium. They discussed the long-term effects of herbicides and defoliants used by the US armed forces with the agreement of the Saigon administration on man and nature during the Second Indochina War, 1961—1975.

At the plenary sessions and working groups the scientists presented some 72 scientific reports and papers dealing with the following problems:
— The long-term effects of military herbicides and defoliants on man (29 reports) and on nature (43 reports).

— The results of experimental studies on herbicides in laboratories or in the field on a small scale.

— The results of studies on the consequences of herbicides from accidents occurring in factories producing them and their effects on groups of workers dealing with chemicals used in agriculture.

Scientists exchanged views, evaluated the results of studies in laboratories and in field experiments. They discussed the research work to be conducted in the near future aimed at eliminating the consequences of the indiscriminate use of herbicides and defoliants on a large scale. They also discussed the possibilities of international cooperation in the field of research.

During the time the symposium was held the scientists visited an exhibition displaying all kinds of chemical weapons used during the war and the effects of herbicides and defoliants on nature and man.

Participants in the symposium also visited the Ma Da forest area, Dong Nai province (in the former Long Khanh province, War Zone D, South Vietnam). Here wartime destruction caused to nature remains very apparent. Ma Da can in effect be considered as a model for experimental field studies as regards the direct and indirect effects of herbicides and defoliants on tropical inland forests, including fire. The visit to the Ma Da forest
gave participants a clear idea of the lengthy duration of effects of herbicidal disturbance on the natural restoration of tropical inland forests.

At the symposium scientists were engaged in active work in a friendly atmosphere. Although most scientists met one another for the first time, their discussions and exchanges of views were conducted in an open, straightforward and frank way and in their private capacities, and this helped ensure good results.

The majority of the participants reached agreements on the following:

1. Operation Ranch Hand was essentially a chemical war conducted with herbicides on a large scale in space and time, the first such massive employment in mankind's history of war. It differed completely from explosion accidents or failures in chemical factories. It was conducted in a tropical country and a geographical area which differs from much smaller-scale experiments in laboratories in any country in the world, or from small experiments in laboratories. The results of these studies and occurrences are only of partial usefulness to evaluate what happened to Vietnam and the Vietnamese people during Operation Ranch Hand.

The herbicide employed in Operation Ranch Hand included primarily:

1. 2, 4-D
2. 2, 4, 5-T (containing dioxin)
3. Picloram
4. Dimethylarsenic acid.
These 4 chemicals were applied primarily in the following 3 mixtures:

1. Agent Orange (a mixture of 2, 4-D and 2, 4, 5-T)
2. Agent White (a mixture of 2, 4-D and picloram)
3. Agent Blue (dimethylarsenic or cacodylic acid).

According to official U.S. figures, about 44 million litres of Agent Orange were used between 1961 and 1970; about 20 million litres of Agent White were used between 1966 and 1971; and about 8 million litres of Agent Blue were used between 1961 and 1971. There is no source of independent verification.

It is impossible to determine how much dioxin was in the Agent Orange, but a conservative estimate is that the total amount was no less than 170 kg.

2. Over the last twenty-odd years, many experimental studies on herbicides and defoliants have been conducted in research bases in many countries. No full agreement has been reached yet on the results and conclusions regarding the effects of chemicals on experimental animals. However, through many years of research with admirable patience and increasingly precise methods, the majority of scientists recognize that phenoxy and certain other herbicides and defoliants used at a high dose or at a low dose for a long period of time will affect animals: they may be variously mutagenic, carcinogenic or teratogenic.

3. Studies on workers in factories producing herbicides and defoliants have also been conducted...
over the last few years. Those studies confirm the toxicity of herbicides, especially of 2, 4, 5-T (2, 4, 5-trichlorophenoxyacetic acid) and of 2, 3, 7, 8-tetrachloro-dibenzo-p-dioxin (TCDD) or dioxin.

The signs of immediate and long-term poisoning due to chlorophenoxyacetic substances have been described in the medical literature in which manifestations considered as characterising such poisoning are: chloracne, porphyria cutanea tarda, asthenia, etc. In human pathology reactions to the pathogenic agents differ from one individual to another; so do the manifestations of the reactions, which renders evaluation and statistics difficult.

4. The symposium reserved most of its time for the evaluation of the long-term effects of chemical warfare in Vietnam. Scientists attending the symposium highly valued the contribution made by Vietnamese scientists who, despite the limited facilities and other difficulties during and after the war, were able to overcome these problems and made valuable research contributions. The reports and suggestions made by Vietnamese scientists at the symposium provided a crucial basis for discussions in the working groups and at the plenary sessions. Large-scale field studies done by Vietnamese scientists in localities in southern Vietnam as well as northern Vietnam have provided many materials of scientific value not previously demonstrated in other countries.

5. Nature in Vietnam has been substantially damaged. This destruction is due to a complexity of reasons. The delegates agreed that the main and
most important cause of this extensive damage to nature is the use of herbicides and defoliants on a large scale. Immediately after the spraying the toxic substances exerted their direct destructive effects on the vegetation and to some extent on animals living in inland or mangrove forests, and on saline water or fresh water animals. The direct and indirect repercussions of these immediate effects have lasted until today. Time has only slowly helped to eliminate these effects and has not yet allowed the restoration of the areas sprayed with toxic chemicals. The restoration can only be slow and occurs most readily on very small areas. Photographs taken from the air or space have only partially reflected the real state of the restoration of tropical forests sprayed with defoliants.

6. Toxic chemicals sprayed on a large scale, with a high concentration and in a large amount, have changed the composition of some soils, destroyed useful microorganisms, and in some instances caused the soil to lose fertility and to deteriorate in other ways. Many areas which were covered with trees and other woody plants throughout the year have become savannas of low productivity with only wild grasses or a number of secondary successional plant species of little economic value, and full of rodents, which are disease-carriers. Evidence from aerial photography and elsewhere indicates that some of these savannas are continuing to expand in size. Some areas of precious tropical woods are facing the danger of extermination, as are some precious terrestrial or aquatic animals and algae, etc. Transforming these savannas and build-
ing them into economic zones, areas for agricultural
cultivation and reforestation, are difficult problems,
the solution of which is far beyond the present
abilities of the Vietnamese people. Moreover, the
various impacts on nature undermine the whole
human life support system.

7. Toxic chemicals sprayed on the land were
washed away to lowland areas, far from the
sprayed areas and decomposed in time. The most
dangerous among them was Agent Orange, which
was widely used from 1961 to 1970. Agent Orange
contains an impurity, 2, 3, 7, 8-tetrachloro-dibenzo-
para-dioxin (TCDD) generally known as dioxin, a
very toxic and resistant substance which exists for
a long time in nature. What was the amount of
toxic chemicals sprayed? According to published
data, more than 90,000 tons of herbicides were
sprayed, including more than 57,000 tons of Agent
Orange, containing the toxic substance dioxin.
However, the most important thing one should know
is whether dioxin still exists in nature in Vietnam.
In 1981 analyses were made of 7 soil samples taken
in a rural area of Ho Chi Minh City, at different
depth levels. On a sample taken at a depth of 1
metre there was a trace of dioxin, with a concen-
tration below 5 p.p.t. of soil. On a wet sample on
the soil surface the concentration was 14 p.p.t. of
soil.

8. There are as yet not many scientific studies
identifying the biological cycle of dioxin from the
soil into plant species, into food, into animals and
people.
Dioxin and decomposition products of herbicides and defoliants have probably been carried to lowland areas in Vietnam and neighbouring countries, and into the seas around Vietnam. Where will these substances end up? How will they be decomposed? What danger will they cause? When will the dioxin decompose? These points cannot yet be established. The opinions put forward at the symposium were only estimates which must be verified over a long period of time.

9. The evaluation of the long-term effects of herbicides and defoliants is a most difficult and complex task. It is therefore difficult to reach full agreement, since the conditions in which scientists work differ from one country to another. However, most of the conclusions drawn by Vietnamese scientists in their reports have corroborated the results of experiments conducted by the majority of scientists in the world and Vietnam. Reports by Vietnamese scientists have suggested that herbicides and defoliants affected chromosomes and caused congenital abnormalities, molar pregnancies and chorio-epithelioma. Vietnam war veterans exposed to toxic chemicals for a long time during the war years may pass on those abnormalities to their offspring. The rate of monsters in families of Vietnam war veterans seems to be higher than in ordinary families. Research studies also give some data as to how toxic chemicals affect people's health and how they cause cancer. Herbicides penetrating into human bodies may cause long-term effects even though the victims have already left the conta-
minated areas. Of course, such effects would be clearer for those who remain in the affected areas.

Any of the preliminary conclusions of Vietnamese scientists are new points, which were observed in the realities of Vietnamese society, and have never been dealt with or else have been only inadequately dealt with in foreign research works.

10. During the symposium scientists agreed that:

a) Further studies should be continued for many years on the long-term effects of herbicides and defoliants used in the war on man and nature in Vietnam.

b) International cooperation between Vietnamese scientists and their foreign colleagues is necessary to promote study and to determine the effects of herbicides and defoliants, and find measures to cope with them, in the interest of the Vietnamese people and other peoples. Thus, this international symposium in Ho Chi Minh City had a humanitarian character, which is serving the interest of the people.

c) Measures to cope with the effects of herbicides and defoliants are complicated and difficult. They involve many fields of science, technology, culture, economy and management and call for appropriate governmental policies. They require a high level of science and technology divorced from politics, the cooperation and commitment of the whole population, and significant investments of money and material. Unrestricted assistance from the international community in all fields related to this endeavor is an urgent necessity.
Finally, a brief separate document provides background information on the subject of the symposium and the following 7 additional documents, provide official summaries of the symposium working groups:

1. Plant Ecology and Forestry;
2. Animal Ecology;
3. Soil Ecology;
4. Coastal and Aquatic Ecology;
5. Cancer and Clinical Epidemiology;
6. Reproductive Epidemiology and
7. Experimental Toxicology and Chemistry.

FINAL SUMMARY REPORT
OF WORKING GROUP E1
ON PLANT ECOLOGY AND FORESTRY

The massive use of chemical defoliants and herbicides in the war against Vietnam is an event without precedent in history. It has produced many effects on the agriculture and ecosystems of Vietnam, only a small part of which are currently understood. We see the need for a large-scale coordinated program to accomplish the following objectives:

1. to establish an accurate inventory of the extent and severity of the damage and changes caused by the defoliation.
2. to estimate the extent of spontaneous regeneration in the forests and other ecosystems. For such work, existence of reliable descriptions of forests of this region provides a necessary base of data.

3. to develop policies of land management, regeneration, and agriculture that will encourage such regeneration, minimize the damage and restore the land and forests to maximum productivity and stability, and

4. to devise systems of international aid and cooperation to implement those beneficial policies which are beyond the financial and technological means of the Vietnamese nation.

Over the decade starting in 1962 at least 14 per cent of South Vietnam's forests were sprayed at least once, and many were sprayed repeatedly. Vietnamese estimates quoted by Hoang Dinh Cau in his plenary lecture set this figure at 44 per cent. The extent of permanent damage is correlated with the total defoliant dose, as judged by matching aerial photographs with military spray records. The degree of initial damage and the rate of recovery from such damage depends on many factors, including the species involved, the dosage, the total area sprayed, the terrain and the weather patterns. Similarly spontaneous regeneration varies widely in the affected areas, and depends mainly on the species, the area affected and the weather. The existence of prolonged dry season in Vietnam certainly impedes regeneration and in some areas natural regeneration has not occurred, making plantations essential. In one studied region, the Dong
Nai forest, regeneration has proceeded very slowly over the last decade, as judged from satellite pictures and on the ground studies.

Frequently, the nearby availability of seeds is the critical factor determining regeneration. The regenerated forest may differ significantly from the original in terms of economically important species. Inventories must be made of these changes.

Once an area has been defoliated, it may be prevented from recovery by human intervention. We note, for example, repeated burning of the grass and small woody cover of defoliated areas such as in the Ma Da forest and the conversion of some such areas to agriculture. Such conversions, once effected, are difficult to reverse and such land might best be left to agriculture.

Once policies have been developed to foster recovery, laws and social practices should be developed to minimize the deleterious effects of those practices that prevent recovery.

The ecological damage produced by herbicidal spray may also become spontaneously worse with time. For example, areas denuded of vegetation may suffer erosion or other deleterious transformation, or they may become invaded by noxious plants such as Imperata which impede restoration of the original flora. The extent of such transformation, representing possible permanent loss of forestlands, should be accurately estimated.

With regard to agriculture, some 13 million hectares of cultivable area seem to have been lost by the spray operation, partly because of the high concentrations of herbicides used in the spray. The
problems underlying agricultural restoration require separate and intensive study, to determine for example possible danger from toxic residues, effects on soil microflora, and best crops to use in the new agricultural effort in these areas. Making recommendations for vegetational restoration in Vietnam is difficult, because the complexity of the landscape and the variation of local conditions make generalizations impractical and even counterproductive. Each separate area must be given independent analysis. While ingenious and provocative models have been proposed to estimate productivity and performance in a forest ecosystem, it is premature to expect these models to be usefully employed in the field in Vietnam. We are impressed by the high quality and prodigious quantity of work accomplished by our Vietnamese colleagues under difficult conditions and with very little support. This encourages us to urge that their research be supported in concrete terms.

Such information as we now have, admittedly fragmentary, permits the conclusion that the combined ecological, economic and social consequences of the defoliation operation are vast, and will take several generations to reverse, and deem it appropriate that international agencies adopt steps to condemn such warfare against the environment and to ban such practices from any future military operations.

Pilot schemes:

We believe that a useful approach to restoring the forest resources would be by means of a pilot
scheme for a small selected area. This could be started immediately and would provide valuable experience while a large long-term scheme was being organized. The forest at Ma Da which we visited in January might be suitable for such an experiment within this forest if protected from fire. It would be possible to find (1) areas of undamaged forest which could serve as seed sources and a base of reference (2) areas of herbicide-damaged forest needing to be restored to full productivity by encouraging natural regeneration or by conversion to plantation of pines or oilier fast-growing trees and (3) areas of scrub and grassland which might be re-afforested. The cost of such a pilot scheme would not be large and could perhaps be met by grants from UNEP, FAO and UNESCO.

FINAL SUMMARY REPORT
OF WORKING GROUP E 2
ON TERRESTRIAL ANIMAL ECOLOGY

Chemical defoliants were sprayed in high concentrations and over large areas of forest in South Vietnam from 1961 to 1971, damaging the forest environment and causing the death of countless animals. The working group reviewed two papers reporting the results of two years of study of the effects of massive herbicide-spraying in A Luoi valley, Binh Tri Thien (formerly Thua Thien and

/...
Quang Tri) province. This 10,000-ha valley was 80\% tropical forest supporting a rich fauna, but was degraded to grassland. A research team led by Professor Vo Quy of Hanoi University interviewed a cross-section of the inhabitants of ten villages in the valley who witnessed the immediate results of chemical spraying. These people consistently reported that spraying was followed within a few days by the death of large numbers of both wild and domestic birds and mammals. There have been no studies investigating the contribution to this mortality from direct toxic effects of chemicals versus indirect effects such as starvation or disease that would follow the destruction of the forest environment of animals.

An important comparison between A Luoi valley and two control forest areas of numbers of bird species, by professor Vo Quy, and number of mammal species, by Dr. Dang Huy Huynh, was presented and discussed. Only 24 species of birds and five species of mammals were found in A Luoi valley, while 145 and 170 bird species and 30 and 55 mammal species were censused in the control forests.

Two other studies were reported. Dr. L. N. Medvedev stated that termite abundances were lower in a sprayed forest site compared to an unsprayed forest site of similar forest structure. Dr. Tran Thong reported higher incidences of reproductive problems and birth abnormalities among domestic pigs in a village subjected to chemical spraying compared to an unsprayed village.

Visits to defoliated forests and examination of aerial photographs of sprayed and unsprayed
forests have shown that tropical forest has been transformed by chemical warfare to two types of degraded vegetation. First, forest repeatedly or intensely defoliated over large areas was often subsequently burned, leading to the establishment of grassland. Examples are A Luoi valley and large areas within and to the north of Ma Da forest reserve, Dong Nai province. Second, over large areas of forest less frequently sprayed, plants of the upper layers of the forest were killed, resulting in a forest of low stature relatively poor in animal species. Thus in defoliated areas, tropical forest supporting a rich fauna of invertebrates and vertebrates has been destroyed, together with the animals dependent on the microclimatic conditions, food resources, and physical structure of the forest. Populations of animals requiring forest of well-developed structure and high plant species diversity have been reduced and subdivided into isolated areas. These species are now more susceptible to local extinction as a result of the reduction and division of their forest habitats.

This phenomenon was specifically investigated during surveys of endangered species, for example, Rhinoceros sondaicus, Bos sauveli, Pygathrix nemaeus and Lophura edώordeii, and of economically important vertebrates in seven forest areas of South Vietnam by Vo Quy and colleagues.

We suggest the following objectives for further research on the ecological impact of chemical warfare on forest animals. First, thorough ecological
and zoological studies are necessary, especially to quantitatively document differences in animal species richness and abundances in sprayed and unsprayed areas of different types of forest. Second, field ecological studies should be combined with laboratory investigations of particular animal taxa to discover species useful as bioindicators of herbicides and/or ecosystems, and to investigate if long-term reproductive problems have resulted from genetic damage to wild and domestic animals surviving chemical poisoning. Third, the distribution of any residual chemicals in the ecosystem should be assessed. Fourth, long-term research plots in forest recovering from chemical spraying should be established to monitor changes in their animal communities. Fifth, more surveys should be conducted to identify and categorize the remaining forests of southern Vietnam and their animal components.

We stress that recommendations from animal ecologists for forest rehabilitation must be integrated with economic studies of how best to utilize these altered lands for the economic and social needs of the people. We have two immediate recommendations to offer. First, we suggest establishing a system of rational biological reserves to protect and manage what remains of the rich diversity of animal life in the forests of southern Vietnam. Second, we are especially concerned about further reductions in forest cover caused by the spread of grasslands. This process was set in motion by chemical warfare. We suggest that efforts be devoted to reafforesting grassland to rejoin small
patches of forest that are now isolated from one another and form barriers to animal dispersal.

Finally, we suggest that biological institutions within Vietnam seek expert assistance and funds from international agencies such as the Food and Agricultural Organization (FAO), the United Nations Development Program (UNDP), the International Union for the Conservation of Nature (IUCN), United Nations Environmental Program (UNEP), UNESCO [especially its Man and the Biosphere (MAB) program] and the World Wildlife Fund (WWF).

Our working group wishes to emphasize that the complexity of, and interrelationships among these ecological problems require cooperation among botanists, zoologists, soil scientists and aquatic biologists to aid in the rehabilitation of the fauna of forests devastated by chemical warfare.

FINAL SUMMARY REPORT
OF WORKING GROUP E3
ON SOIL ECOLOGY

The use of herbicides in the Vietnam war has caused heavy damage and long-term consequences on soil ecosystems and this may affect agricultural and forest production and ultimately man's health. This response of outrage to large-scale wartime
use of herbicides for crop destruction and forest defoliation should not deny the benefits of their use to farmers and workers in the forest during times of peace.

The soil working group was concerned with the effects of the wartime use of herbicides on the chemical, physical, and biological properties of soil.

The effects of herbicides on soil may be indirect or direct. Their indirect effect occurs through changing the vegetation and its influence upon soil properties. Their direct effect occurs when they enter the soil, becoming part of soil organic matter degradation processes or affecting the microbiology of soil. The magnitude of changes induced upon soil properties will vary depending upon other variables which influence the soil ecosystem, for example, the geologic conditions, the topography, and the degree of development of the soil.

Our group heard and discussed papers which dealt with three main soil topics: 1) The changes in soil properties that have occurred since herbicides were applied during the Vietnam war. 2) The effect of the herbicides on the ecosystem of soil micro-organisms. 3) The fate of herbicides entering the soil in the processes of degradation and their resulting products.

The major points made in these reports are:

1. A large proportion of the elements of site fertility are contained in the trees relative to the soil in undisturbed tropical forests. Herbicides bring about a sudden return to the soil of the foliage of vegetation with its elemental content. Rapid decay of this detritus brings a flush of organic matter, nitrogen
compounds and associated mineral elements to the soil. This changes soil properties with the increase in these materials. This may be temporary or long lasting depending upon many factors such as rate of recovery of original vegetation, amount of conversion to other types of vegetation, or land uses and the topography, and degree of erosion.

2. Loss of soil fertility elements may occur depending upon the intensity and duration of vegetation change induced by herbicides. Repeated application resulted in greater opening of forest and conversion to other types of land use. The fertility content of the site in soil and vegetation became less with the sequence from forest to grassland or bamboo. Soil fertility elements most susceptible to loss are potassium and nitrogen, with a drop in available phosphorus due to incorporation in insoluble forms.

3. In a study made in the A Luoi valley, Vo Quy reported changes in soils collected 12 years after herbicide use had converted forest to Imperata grassland. Periodically, man-caused fires occur and maintain this grassland. Where topography is steep the changes in soil properties were lower organic matter content, lower nitrogen content, less available phosphorus and lower calcium, magnesium and iron on the soil cation exchange complex. The soil increased in acidity and aluminum content. Where topography was flat as in the valley bottoms with alluvial soils, there were increases in the soil organic matter and nitrogen content.

A study of mangrove forest soils at Ca Mau showed soils in areas cleared of mangroves increased
carbon and nitrogen contents, lower soil pH, available phosphorus was less, and soil potassium was lowered when compared with uncleared forest. Where cleared soils were used for agriculture there was a drop in nitrogen contents but organic matter remained high. Deterioration due to acid sulphated soil formation has occurred in some of these mangrove areas such as U Minh and Ca Mau.

4. Herbicides and pesticides directly entering the soils and transmitted through the plant to root exudates may affect the species composition of soil microorganisms. There may be a selection for those species which can decay the unique organic compounds (xenobiotic) applied. These organisms will aid in the decomposition of the herbicides but also could possibly form degradation compounds which are toxic.

5. 2, 4-D and 2, 4, 5-T have been used as herbicides and plant growth regulators for 40 years. If essential combination of microflora are present 2, 4-D and 2, 4, 5-T are fairly quickly degraded to non-toxic products.

However, picloram is more stable in soil, being detectable for up to 3 years. Arsenic from cacodylic acid may remain in soil in a fixed condition. Decomposition rates of pesticides in soil will vary depending upon soil physical properties, acidity, microflora composition, and adherence to clays.

One study reported long time persistence of herbicides based upon phenol analysed. This persistence may be related to fixation in soil organic matter or clay minerals in the soil.
RECOMMENDATION

Our group makes these final proposals for international long-term cooperation of interested scientists:

1. Total ecosystem studies are needed to understand the role of herbicides and pesticides (xenobiotics) in geochemical cycling and their effects upon soil fertility.

2. A survey should be made of land use in herbicide-treated areas and the resulting sequence of vegetation change. The survey should include locations of any areas of intensive land deterioration due to erosion.

3. Techniques of restoration of soils deteriorated by adverse aspects of herbicide use and subsequent land use should be developed and applied. Special attention is needed for acid sulphate soil reclamation.

4. Studies are needed in the persistence of herbicides in soils and their processes of degradation. The role of microorganisms in decomposition and degradation of herbicide materials needs study. Studies of effects upon microfloral composition and selected indices of herbicide presence such as nitrogen fixers, cellulose decomposers and mycorrhizal and plant microflora associates are needed.

5. Studies on special soil topics related to herbicide use are needed such as the possible catalytic effect of clay minerals on photo-oxydation and degradation of herbicides, and the effects of herbicides on processes of soil laterization.
6. Studies should be made on persistence of dioxin contaminants of herbicides in soil and their possible movement in the food chain to man.

7. We recommend that international organizations (UNESCO, UNEP, UNDP, FAO...) and the international scientific community help in collaboration with Vietnamese scientists in the studies of these problems associated with the use of herbicides in the Vietnam war.

We recognize that there are far broader aspects of herbicide use in a global context and that we have confined our discussion to the effects of herbicide use during wartime in Vietnam on soil conditions. Related materials are in the reports of group dealing with agriculture, forestry, mangroves and the chemistry of herbicides.

FINAL SUMMARY REPORT
OF WORKING GROUP E4
ON COASTAL, AQUATIC AND MARINE ECOSYSTEM

During the Second Indochina War, extensive areas of forests were defoliated in the southern part of Vietnam. In particular mangrove forests were periodically defoliated during the period of years between 1961 and 1971 and resulted in the complete destruction of a significant percentage of the forests
in the provinces of Tien Giang, Ben Tre, Cuu Long, Hau Giang, Minh Hai and Ho Chi Minh City (Rung Sat). A U.S. National Academy of Science study team concluded in 1974 that the affected mangrove areas were so intensively damaged that natural recovery might take as long as 100 years, due in part to the loss of seed sources. The destruction at the mangrove forests in the affected provinces resulted in a significant potential loss of timber, firewood, tannin and other forest products and presumably led to a decrease in estuarine and nearshore fishery yields. In essence, a significant percentage of the mangrove ecosystem, including its associated estuarine fauna and flora, experienced a significant productive loss.

The use of defoliants in the upland areas of Vietnam was more extensive, but the subsequent damage was variable compared to that in the mangrove forests. However, the disturbance in the watersheds and the introduction of defoliants into aquatic ecosystems has been associated with aquatic biological changes that are considered to be serious.

This working group on aquatic, coastal and marine ecosystems has reviewed the available information and data and recommends that countries and international organizations supporting the development of the Socialist Republic of Vietnam provide assistance for the: 1) assessment and monitoring of any possible chronic effects, due to residual defoliants, during the process of ecosystem recovery, and 2) the evaluation of productive alternatives for the utilization of the altered habitats for economic and social benefits.
COASTAL MANGROVE ECOSYSTEMS

The data and information that are available for the mangrove ecosystem indicate that the effects of defoliation are long lasting and widespread within the affected areas. The relatively good quality of the available information makes it suitable for the definition of the basic research programs required to assist in the restoration of the habitat, and its fauna and flora, and the directions that should be taken in developing new economic opportunities. The trial plantations of a high-value species of mangrove (*Rhizophora apiculata*) in its former habitat, could accelerate the recovery of the mangrove ecosystem.

However, unsuitable and degraded habitats will require the evaluation and selection of alternative economic uses.

Whereas it is doubtful that toxic residues persist in significant concentrations, there is a reasonable probability that the defoliated and altered watersheds continue to have an impact on the downstream coastal mangrove forests. Altered hydroperiods, excessive erosion and deposition, and introductions of deleterious materials could have a significant effect on the fauna and flora of the mangrove ecosystem and estuarine areas. Insufficient quantitative data exist to assist in evaluating these possible impacts.

INLAND AQUATIC ECOSYSTEMS

Compared to the existing knowledge of the mangrove ecosystem, defoliant effects are reported in
fewer documents for the potentially affected inland aquatic ecosystems. However, some data and informant reports have been assembled by qualified Vietnamese scientists. These suggest that the existence of defoliation induced adverse effects including the loss of freshwater vertebrate and invertebrate species and caused anomalous deformations among species of the local freshwater algae. Because many questions remain to be answered concerning this topic, a statistically valid assessment study is warranted that determines the characteristics of the altered environments and aquatic components, particularly those that have economic importance.

MARINE ECOSYSTEMS

Vietnamese scientists also confirm earlier reports of declining marine fishery stocks and the disappearance of certain species. Although similar problems are being reported in other countries of the region, the Vietnamese situation cannot be attributed to overfishing and related exploitive fishing practices. It is therefore urgent that fishery stock assessments be undertaken and that local training be provided in fishery management and capture techniques.

RECOMMENDATIONS FOR RESEARCH COOPERATION

Due to the ecological and economic value of Vietnam's coastal, aquatic and marine ecosystems and because Vietnam's opportunities for natural resource
development are limited, this working group recommends that:

1. Vietnam participate in UNESCO's Regional Coastal and Marine Programme by creating a Coordinating National Mangrove Committee and sending participants to Bangkok, Thailand, for training in mangrove biology and management. The National Committee should also serve as an ad-hoc advisory body to monitor the reclamation and restoration of altered ecosystems.

2. Vietnam should solicit cooperation with the Czechoslovakian Academy of Sciences concerning the use of indicator species in monitoring the recovery of inland aquatic ecosystems.

3. Vietnamese scientists and natural resource managers should actively solicit library materials, methodological handbooks and training aids on relevant scientific and management subjects.

RECOMMENDATIONS FOR RESTORATION OF NATURAL RESOURCES

1. Vietnam should undertake statistically-controlled studies of each altered ecosystem for the purpose of explaining why certain ecosystems appear to be slow in recovering, to lay a scientific basis for accelerating the recovery processes.

2. Vietnam should evaluate all alternative potential uses of the altered ecosystems, with emphasis on aquaculture and the harvesting of species not previously utilized in Vietnam.
3. Vietnam should incorporate socio-economic considerations in its natural resource development plans to ensure that maximum benefits are obtained. It is necessary to strengthen international cooperation with Vietnamese scientists for effective assistance in overcoming the consequences of the war in Vietnam.

FINAL SUMMARY REPORT
OF WORKING GROUP P1
ON CANCER AND CLINICAL EPIDEMIOLOGY

1. OVERVIEW LITERATURE

TCDD is one of the most toxic organic compounds, producing a wide range of organ and metabolic disfunctions, fetotoxicity, teratogenicity and carcinogenicity at the p.p.t.-p.p.b. range. There is a general consistency between the pattern of chronic toxicity induced in animals by TCDD and TCDD-contaminated chloro-phenolic compounds and those observed in exposed human populations. Such toxicity includes: chronic hepatitis disturbances in immune function and in lipid — and porphyrin metabolism, and neurological abnormalities sometimes associated with a toxic neurasthenic syndrome. Studies by Ton That Tung on herbicide-exposed Vietnamese populations in the Second Indochina War have produced suggestive evidence of an excess
of primary liver cancers and other evidence of chronic toxicity. A series of Swedish epidemiological studies, confirmed by more recent U.S. mortality studies, have demonstrated an excess of soft tissue sarcomas in groups occupationally-exposed to chlorophenoxy herbicides and chlorophenoxy compounds. Chloracne is not an obligate effect of TCDD exposure in either sensitive animal species or in humans.

2. VIETNAMESE AND OTHER DATA

Morbidity studies on civilians in Tay Ninh and Ben Tre and in Vietnamese veterans in the North have demonstrated consistent and strong associations between herbicide-exposure and chronic neurasthenic symptoms. Two preliminary case-control studies of primary liver cancer were reported. A case-control study of primary liver cancer in Hanoi demonstrated a strong association with herbicide-exposure. Another similar study at Cho Ray hospital with a limited number of cases evidenced a slight excess of risk of liver cancer in exposed persons, but this association was not large enough to achieve statistical significance.

3. EVALUATION OF VIETNAMESE DATA

These studies have established suggestive evidence of an association between herbicide-exposure and chronic toxic effects, including neurasthenic symptoms and primary liver cancer. It is planned to expand these studies with particular reference to
the following: definition of past and present exposure to toxic herbicides including dioxin levels from direct and indirect sources; methodological considerations including the need for larger sample sizes, random sampling, the use of multiple controls and avoidance of reporting bias; incorporation of objective clinical and laboratory studies, such as associations between chronic neurasthenic symptoms and disturbances in nerve conduction velocity and lipid—and porphyrin metabolism; and study of the rule of Hepatitis B in studies for the association between primary liver cancer and exposure to toxic herbicides. The working group recognises the major problems in conducting complex epidemiological studies of this type, even under ideal conditions, and congratulates their Vietnamese colleagues for their scientific contributions under difficult conditions.

4. FUTURE SCIENTIFIC COOPERATION

While primary consideration has been directed to Vietnam, the working group recognizes the existence of similar problems and needs in Laos and Kampuchea following the Second Indochina War. Greatly expanded initiatives should be developed in the following general areas: collaborative programs based jointly in Vietnamese and foreign laboratories; visiting consultant programs involving foreign scientists to work in Vietnam; scholarship programs allowing young Vietnamese scientists to receive
specialised training in foreign countries; development of standardized protocols for epidemiological, clinical and laboratory studies; and foreign reference centres for specialised purposes such as TCDD analyses and histopathology review. Attempts should be made to integrate such initiatives with world wide studies on groups occupationally exposed to dioxin and dioxin-contaminated chlorophenoxy compounds, including foreign veterans of the Second Indochina War, and to develop such initiatives in parallel with programs to improve the overall public health and nutritional status of the Vietnamese population. Recommendations for specific collaborative program include expanded case-control studies designed to investigate the relationship between past exposure to toxic herbicides and present disease in standardized populations and also designed to study associations between subjective disease and objective clinical and laboratory findings and to study the relation between such associations and present dioxin levels in soil, water and vegetation of areas exposed to toxic herbicides, retrospective case-control studies on soft tissues sarcoma; and subject to available resources, long-term prospective epidemiological studies on exposed Vietnamese populations.

5. RECOMMENDATIONS FOR PRACTICAL ACTION

The working group recognises that all recommendations are meaningless in the absence of a workable plan for implementation.
The following recommendations are therefore proposed:

1. Funding should be sought to support further research, diagnosis, and treatment of the effects of exposure to herbicides in Vietnam, Kampuchea and Laos.

2. We should immediately establish practical mechanisms for scientific collaboration. In particular, these mechanisms should include international scientific commissions or committees for collaborative research.

3. The participants in this symposium should make every effort to increase the availability of medical supplies to Vietnamese, Lao, and Kampuchean researchers, also scientific journals, laboratory reagents and equipment.

4. Research concerning the treatment of exposed persons should be part of the overall research program.

5. WHO should be approached concerning the expansion of their IARC-dioxin project to incorporate and support herbicide-effects research in Indochina.

FINAL SUMMARY REPORT
OF WORKING GROUP P2
ON REPRODUCTIVE EPIDEMIOLOGY

The working group accepts without dissent the animal evidence proving the teratogenicity of dioxin when administered to females, but remains unaware
of any acceptable evidence of the transmission of this toxicity through the male.

Although there have been many studies of the medical effects of Agent Orange and related compounds, together with their contaminants, they have been inconclusive as regards reproductive effects and therefore the study of these in Vietnam, where there has been such extensive exposure, seems to be of the greatest interest and importance, not only to Vietnam but also to the rest of the world.

Recognizing, and indeed deeply cognizant, of the extraordinary difficulties necessarily associated with any such retrospective study, especially when it is being carried out some 15 years after the time of exposure, we have been very much impressed by the seven Vietnamese studies that have been reported to us. These evaluations of the possible teratogenic and/or mutagenic effects of herbicide-exposure are being made in three major ways:

1. Changes in the frequency of miscarriages and stillbirths relative to normal deliveries;

2. Changes in the frequency of congenital malformations;

3. and changes in the rate of occurrence of hydatidiform mole.

Changes in miscarriages, stillbirths and congenital anomalies have been studied not only among exposed women (necessarily in the southern part of Vietnam) but also in the children of unexposed women whose husbands have been exposed.

The authors of all these investigations, well aware of the many obstacles to a completely satisfactory
study, have proffered them as preliminary reports even when they already include an immense amount of laboriously acquired information.

The most complete, and perhaps consequently the most impressive and persuasive studies, relate to an increase in the unfavorable outcomes of pregnancy in North Vietnamese women whose husbands served in the South and were therefore at least potentially exposed to herbicides compared to fellow villagers whose husbands had stayed in the North. Providing the following criteria have indeed been met: a properly carried out blind study, an absence of bias (especially in selection) maximum validation of data other than by self-reporting, and strict adherence to the properly prepared protocol (and we have no specific reason to doubt any of them). Then a statistically valid increase in these unfavorable outcomes has been shown for the wives of exposed fathers in one study and strongly suggested in another which additionally indicates a reversal of the usual increase in the frequency of such disasters with progressive pregnancies.

However, it is agreed by all that in such investigations, especially when they show results contrary to previous experimental evidence, one or even two or three congruent investigations are not enough to provide complete proof of their conclusions, and further similar work is needed.

As regards congenital anomalies, there are several studies apparently indicative of a generally higher rate of their frequency among exposed women but these changes are often hard to prove beyond any doubt. The absolute rate of reported congenital
anomalies in Vietnam seems generally very low. Although the reasons for this are not fully understood, they may include the low sensitivity of the information system, reduced exposure to toxic chemicals and inherent ethnic differences.

We are much impressed by the large number of reported cases of the following categories of congenital anomalies:

1. Anencephaly and other neural tube defects, which in this case are associated with a remarkably low incidence of spina bifida;

2. Deformities of the sense organs such as anophthalmia;

3. Deformities of the limbs including phocomelia;

4. Conjoined twins;

5. Orofacial cleft defects.

In most other countries these malformations are either not very common (anencephaly, orofacial clefts) or even rare (deformities of limbs, anomalies of sensory organs and conjoined twins).

In order to appropriately further pursue this important field of inquiry, at least two things are essential: a more precise identification and classification of reported anomalies, and a determination of the expected rate of such deformities in Vietnam either by the recovery of accurate pre-spraying figures or, second-best, the use of data from closely related populations available through WHO for the years 1962-1963 for India, Hong Kong, Malaysia and Singapore, or, minimally, by determination of the worldwide reported range of frequency.
Hydatiform moles again seem to show an increase in frequency in exposed women but more work is needed if this is to be proved. Recognizing the relatively high frequency of this lesion in Southeast Asia, information should be obtained as to any recent changes reported elsewhere in the area.

We feel that the general design of the studies reported is excellent but that additional numbers are needed, controls made somewhat stricter, possible variables carefully scrutinized and protocols rigidly adhered to. Until now exposure index has rarely been included and no sort of dose-response curve has been constructed. Consideration should be given to comparing the possible results of direct exposure compared to exposure via the diet. Search should perhaps be made for other possible toxins such as heavy metals or DDT.

Finally we would point out that even if all of these studies, as designed, were to yield unequivocally positive results even then only the increased defects resulting from exposure would have been proved, not the specific association with dioxin, which would remain presumptive until the causal relationship was confirmed by separate investigations. These would be made easier if the newest methods of chemical analysis can, indeed, still demonstrate residual dioxin at variable levels in human tissue.

The group agrees that the remaining problems of the possible teratogenesis of herbicides requires ex-
tensive continued study by the scientists of Vietnam in which they could be appropriately aided by the international community, especially with respect to laboratory experimental investigations.

FINAL SUMMARY REPORT
OF WORKING GROUP P3
ON EXPERIMENTAL TOXICOLOGY
AND CHEMISTRY

(including Cytogenetics, Dioxin and Related Chemistry)

CHEMISTRY

Chemical warfare agents of the herbicide and defoliant category were used in South Vietnam between 1961 and 1975 and on a massive scale in the mid to late 60’s. A diverse group of chemicals was used including Agent Orange and its analogs, as well as Agents White and Blue.

According to the US National Academy of Sciences the quantity of herbicides and defoliants used in Vietnam was about 90,000 tonnes. A.H. Westing has also reported a similar tonnage. Vietnamese scientists, however, believe that the quantity used was greater than this and that the amount exceeded 100,000 tonnes. This higher estimate includes harassing agents such as CS.
All of the chemical warfare agents used were sprayed over an area of approximately 38,000 square kilometers. The concentration of chemicals used varied from between 15 -20 kg/hectare to 300kg/hectare in unusual circumstances (average about 30 kg/ha). Agent Orange and its analogs made up approximately 80% of the herbicides and defoliants employed in South Vietnam. Agent Orange and its analogs contained the highly toxic contaminant 2, 3, 7, 8-tetrachloro-dibenzo-para-dioxin (TCDD). According to official US figures quoted by A.H. Westing approximately 57,000 tonnes of Agent Orange and its analogs were sprayed and this quantity of herbicide contained not less than 170kg of TCDD. Some participants of the working group agreed with this figure, but a majority came to the conclusion based on some published data — that the total amount of TCDD sprayed over Vietnam was greater than 500kg.

Some delegates did not agree with this assumption. Based on analytical data from samples left over from the spraying program in Vietnam and the amounts of 2, 4, 5-T produced in different factories, in different years, and subsequently sprayed, they arrived at a total figure of about 170kg.

Due to the high toxicity of 2, 3, 7, 8-TCDD and the large variation in toxicity between different isomers the analytical method used in dioxin analysis should have good reproducibility, a very high sensitivity (in the 10^-12 g/range) and they should allow the quantification of specific isomers, especially the 2, 3, 7, 8-TCDD isomer.
To date 2, 3, 7, 8-TCDD has been found in several different types of samples, including formulations, soil, sediment, vegetation, fish, and animal tissue, bovine and human milk, human blood, liver, kidney and adipose tissue.

Although 2, 3, 7, 8-TCDD is the major impurity found in Agent Orange, it should be pointed out that other dioxins such as 1, 3, 7, 8-and 1, 3, 6, 8-TCDD; 1, 3, 7-tri-CDD; 2, 7-and 2, 8-dl-CDD have also been reported together with a series of dibenzofurans.

TCDDs have also been found in other technical products. Of special interest is the existence of 1000 ppm of TCDDs in diphenyl ether herbicides used in ricefields. The major isomers are 1, 3, 6, 8-and 1, 3, 7, 9-TCDD but other isomers have also been identified; however, 2, 3, 7, 8-TCDD has not been found. Secondary formation of TCDD after spraying has also been discussed (photochemical and pyrolytic formation). The ecological situation is very complex, however experimental data do not indicate any extensive secondary formation of the dioxin. Burning of 2, 4, 5-T salts results in high yields of TCDD.

A series of experiments have demonstrated the bioavailability of TCDD in soil and sediments. It is therefore recommended that tissue samples from both aquatic and non-aquatic animals should be analysed for TCDD.

The degradation of TCDD in soil is very slow, a half-life of greater than 10 years has been reported. The metabolism and excretion of TCDD...
from primates seems to be quite slow with a half-life of about 1 year. In small rodents the degradation is reported to be much faster.

Analysis of the parent phenoxy herbicide (2, 4, 5-T, 2, 4-D) in various samples can be done by standard methods (HRGC), however the presence of trace levels should be confirmed by an additional technique, e.g. mass spectroscopy.

For the analysis of arsenic atomic absorption and X-ray spectroscopy are the methods with the best sensitivity and reproducibility.

RECOMMENDATIONS

The working group recognized two analytical studies of samples from Vietnam. In fish samples from the early 70's Baughman found up to 800 ppt of TCDD. In a recent study Olie identified small amounts (up to 30 ppt) in soil and sediment samples from Vietnam. The working group recommends further research on critical samples like soil, sediments, fish and other aquatic animals, human milk and human tissue samples. The first phase of such a project should include a brief screening of "grab samples" followed by systematic sampling in the presence of international organizations like UNESCO and/or UNEP. After coding the samples together with control samples should be sent in a "round robin" study to different laboratories, e.g.

* Amsterdam
* Moscow
* Hanoi, Ho Chi Minh City
* Umea, Sweden
* Lincoln, Nebraska
GENETIC EFFECTS OF HERBICIDES

Vietnamese scientists using standard non-banding cytogenetic techniques and sister chromatid exchange methods for investigations on chromosome aberrations have reported an increase in chromosome aberrations and sister chromatid exchange on adults and their children directly exposed to herbicides in South Vietnam. These people are still living in the sprayed area. A control group was selected from South Vietnam.

The abnormalities reported include chromatid breaks, chromosome breaks, translocations and polyploid cells. Some of these are rarely seen in human beings, especially ring chromosomes, translocations with quadriradial figures, and endoreduplications. The above-mentioned genetic aberrations have been found many years after the chemicals had been sprayed. According to the Vietnamese scientists similar aberrations have been reported for victims of radiation exposure in Japan following the dropping of atomic bombs. And the Vietnamese scientists believe that their findings indicate that there has been a long-term health effect on the victims of herbicide exposure.

The above information has been extended by other Vietnamese scientists who reported an increase of chromosome aberrations on spermatogonia and primary spermatocytes caused by 2, 4, 5-T in in vivo tests on the white mouse (Mus musculus).

Delegates discussed papers indicating absence of mutagenicity in Drosophila (fruit flies) and absence of mutations for dioxins in the bacterial Ames test.
but the presence of mutations when dioxin was tested in a mammalian cell transformation assay.

Comments on findings of Vietnamese scientists In the opinion of the group the work of the Vietnamese scientists is interesting, but because of the controversial nature of the published literature on genetic effects of these herbicides further studies by additional laboratories are needed.

CARCINOGENICITY

One delegate presented evidence on the carcino-
genicity of 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (dioxin) in rodents. The paper considered alongside the 5 already published in the scientific literature indicates that there is now sufficient evidence to class dioxin as a carcinogen in a number of animal species. It is not yet clear, however, whether dioxin acts directly or indirectly to cause cancer. However, the work presented in the group on the mutagenicity of dioxin in a cell transformation assay suggests that this chemical is an initiator and can cause cancer. Evidence was also presented for the carcino-
genicity of the herbicide 2, 4, 5-trichlorophenoxy-
ethanol in rodents.

TOXICOLOGY

One delegate presented evidence for the toxicity of herbicides (2, 4-D and 2, 4, 5-T) in fruit flies at 1000 ppm and 300 ppm respectively. The toxic effects included total failure of the life cycle of the fly at these doses, and proportionate survival at lower doses with a developmental delay which was not teratogenic, but which caused changes in the duration of the life cycle, the sex ratio of the
emergent population, and the time of maturation of the flies. It also included behavioural modifications in the choice of media for egg laying. Media without herbicide were preferred for egg laying over those with either 2, 4-D or 2, 4, 5-T, or a mixture of these (The dioxin content of the 2, 4, 5-T tested is not known). Two other delegates reviewed the scientific evidence on the cytotoxic effects of halogenated hydrocarbons and on the toxicity (including delayed toxic effects) of chemical warfare agents in general.

The mode of action of the chlorinated pesticides, polychlorinated dibenzofurans, and dioxins was discussed with reference to their action in the liver. Chemical warfare agents were reported to have delayed toxic effects in humans and it was recommended that a considerable research effort was required to find out more about this problem. In particular, it was suggested that workers employed in the manufacture of chemical weapons be studied for any long-term health problems.

RECOMMENDATIONS

We would like to see:

1. more in vitro studies using eukaryotic organisms with different doses of herbicides to determine different frequencies of chromosome aberrations and gene mutations.

2. Continued monitoring of the population exposed to herbicides to detect any mutagenic and carcinogenic effects in this, and subsequent generations.

3. Cooperation between laboratories on an international basis to facilitate this work.
INTERNATIONAL SYMPOSIUM
ON HERBICIDES AND DEFOLIANTS IN WAR:
THE LONG-TERM EFFECTS ON MAN AND
NATURE

Ho Chi Minh City, 14 — 19 January 1983

MEMBERS OF THE SYMPOSIUM PRESIDIUM:

— Professor HOANG DINH CAU, Vice-Minister of Public Health, Hanoi, Socialist Republic of Vietnam.
— Academician ALEXANDER V. FOKIN, Secretary-General of the Soviet Academy of Sciences, Moscow, USSR.
— Professor VLADIMIR LANDA, Czechoslovakian Academy of Sciences, Prague, Czechoslovakia
— Professor ARTHUR H. WESTING, Hampshire College, Amherst, USA.

ADMINISTRATION:

— HOANG DINH CAU (SRV)
— TRINH VAN KHIEM (SRV)
— DOAN XUAN MUOU (SRV)
— PHAM NGOC QUE (SRV)
— WESTING, A.H. (USA)
— WESTING, C.E. (USA)

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APPENDIX

LIST OF PARTICIPANTS

1. Prof. TRINH KIM ANH  Director of Cho Ray Hospital, Ho Chi Minh City, Vietnam (Medicine)

2. Prof. NIKOLAI S. ANTONOV  Ministry of Public Health, Moscow, USSR (Oncology)

3. Prof. PETER S. ASHTON  Arnold Arboratum, Harvard Univ., Cambridge, USA. (Botany)

4. Prof. EVGENI L. ASTACHKIN  Research Institute of Biological Testing of Chemicals, Moscow Region, USSR. (Biochemistry)

5. DOAN THUY BA  M.D., Vice-Director of Cho Ray Hospital, Ho Chi Minh City, Vietnam. (Medicine)

6. TON THAT BACH  M.D., Viet—Duc Hospital, Hanoi, Vietnam (Oncology)

7. BAIKO D. BAIKOV  Doctor of Science, Centre of Biology, Academy of Sciences, Sofia, Bulgaria. (Ecology)

8. LUIGI BISANTI  Instituto Superiore de Sanita, Rome, Italy. (Epidemiology)

9. VALENTIN A. BOLSHAKOV  Doctor of Science, Institute of Cell Science, Academy of Agriculture, Moscow, USSR (Soil Science)

10. GEORGI BORISSOV  Doctor of Science, Centre of Chemistry, Academy of Sciences, Sofia, Bulgaria. (Organic Chemistry)
11. EBERHARD F. BRUNIG  Doctor of Science, Institute for World Forestry, Hamburg, F.R.G. (Forestry)

12. Prof. LE VAN CAN  National Centre of Science Research, Vietnam.

13. Prof. NGUYEN CAN  Director of Institute for Protection of the Mother and Infant, Vietnam. (Surgery)

14. Prof. HOANG DINH CAU  Vice-Minister of Public Health, Vietnam. (Surgery)

15. Prof. ELOF A. CARLSON  Dept. of Biochemistry, State University of New York, Stony Brook, USA. (Genetics)

16 Prof. HENRI CARPENTIER  Paris, France (Oncology)

17. CHAN TONG YVES  Eng., Ministry of Agriculture, Phnom-Penh, Kampuchea. (Botany)

18. ALEXEI CHESNOKOV  Doctor of Science, Dept. of Science Organization, Academy of Sciences, Moscow, USSR (Biochemistry)

19. NGUYEN TRAN CHIEN  M.D., Candidate of Science, Medical College of Hanoi, Vietnam (Genetics)

20. Prof. VU TA CUC  Medical College of Hanoi, Vietnam. (Chemistry)

21. LE TRONG CUC  Candidate of Science, Dept. of Biology, University of Hanoi, Vietnam. (Soil Science)
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<th>No.</th>
<th>Name</th>
<th>Institution</th>
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<tr>
<td>22</td>
<td>VO TRI CHUNG</td>
<td>Eng., Institute of Forestry Planning, Hanoi, Vietnam. (Forestry)</td>
</tr>
<tr>
<td>23</td>
<td>Prof. JOHN D. CONSTANCE</td>
<td>M.D., Dept. of Surgery, Massachusetts General Hospital, Boston, USA. (Surgery)</td>
</tr>
<tr>
<td>24</td>
<td>RENDO DAWA</td>
<td>Institute of Chemistry, Ulan Bator, Mongolia. (Chemistry)</td>
</tr>
<tr>
<td>25</td>
<td>Prof. ZDENEK DIENSTBIER</td>
<td>M.D., Faculty of Medicine, Charles University, Prague, Czechoslovakia, (Oncology)</td>
</tr>
<tr>
<td>26</td>
<td>Prof. DUONG HONG DAT</td>
<td>Ministry of Agriculture, Vietnam. (Agriculture)</td>
</tr>
<tr>
<td>27</td>
<td>VU VAN DUNG</td>
<td>Eng., Institute of Forestry Planning, Vietnam. (Forestry)</td>
</tr>
<tr>
<td>28</td>
<td>NGUYEN DICHO</td>
<td>M.D., Cho Ray Hospital, Vietnam. (Oncology)</td>
</tr>
<tr>
<td>29</td>
<td>DAPHNE F. DUNN</td>
<td>Doctor of Science, California Academy of Sciences, San Francisco, USA. (Invertebrate Zoology)</td>
</tr>
<tr>
<td>30</td>
<td>Prof. JAMES H. DWYER</td>
<td>Dept. of Psychology, State University of New York, Stony Brook, USA. (Statistics)</td>
</tr>
<tr>
<td>31</td>
<td>Prof. SAMUEL S. EPSTEIN</td>
<td>M.D., Dept. of Environmental Medicine, University of Illinois, School of Public Health, Chicago, USA. (Environmental Medicine)</td>
</tr>
</tbody>
</table>
32. KARL RAINER FABIG M.D., Duis Berger St. 46, Dusseldorf, F.R.G. (Medicine)

33. ALEXANDER V. FOKIN Academician, Academy of Sciences, Moscow, USSR. (Chemistry)

34. ZOLTAN FULOP M.D., Medical School, Budapest, Hungary. (Teratology)

35. Prof. ARTHUR W. GALSTON Dept. of Biology, Yale University, New Haven, USA. (Plant Physiology)

36. RUBEN R. GAVALDA M.D., William Soler Hospital, Havana, Cuba. (Immunology)

37. Prof. ARNE VAN DER GEN Dept. of Chemistry, University of Leiden, Leiden, Netherlands. (Organic Chemistry)

38. Prof. TRAN DINH GIAN State Committee of Social Sciences, Hanoi, Vietnam.

39. Prof. HAIM B. GUNNER Dept. of Environmental Sciences, University of Massachusetts, Amherst, USA. (Environmental Biology)

40. NGUYEN VAN HANH Candidate of Science, Agricultural College No. 4, Ho Chi Minh City, Vietnam. (Agriculture)

41. HOANG HOE Eng., Director of Institute of Forestry Planning, Hanoi, Vietnam. (Forestry)
<table>
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<tr>
<th>No.</th>
<th>Name</th>
<th>Institution and Details</th>
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<tr>
<td>42.</td>
<td>Prof. MAUREEN C. HATCH</td>
<td>Faculty of Medicine, Columbia University, New York, USA. (Epidemiology)</td>
</tr>
<tr>
<td>43.</td>
<td>ALASTAIR HAY</td>
<td>Doctor of Science, Dept. of Chemical Pathology, University of Leeds, Leeds, England. (Biochemistry)</td>
</tr>
<tr>
<td>44.</td>
<td>Prof. PHAM HOANG HO</td>
<td>University of Ho Chi Minh City, Vietnam. (Botany)</td>
</tr>
<tr>
<td>45.</td>
<td>Prof. PHAN NGUYEN HONG</td>
<td>Teacher-Training College No. 1, Hanoi, Vietnam. (Ecology)</td>
</tr>
<tr>
<td>46.</td>
<td>Prof. VRATISLAV HRDINA</td>
<td>Faculty of Medicine, Charles University, Prague, Czechoslovakia. (Pharmacology)</td>
</tr>
<tr>
<td>47.</td>
<td>BUI SY HUNG</td>
<td>M.D., Director of Gyn. Obst. Hospital, Ho Chi Minh City, Vietnam. (Medicine)</td>
</tr>
<tr>
<td>48.</td>
<td>HOANG VAN HUAY</td>
<td>Candidate of Science, University of Hanoi, Vietnam. (Soil Science)</td>
</tr>
<tr>
<td>49.</td>
<td>DANG HUY HUYNH</td>
<td>Candidate of Science, Institute of Biology, Centre of Science Research, Vietnam. (Mammalogy)</td>
</tr>
<tr>
<td>50.</td>
<td>LE DIEM HUONG</td>
<td>M.D., Gyn. Obst. Hospital, Ho Chi Minh City, Vietnam. (Epidemiology)</td>
</tr>
<tr>
<td>51.</td>
<td>Prof. CHRISTOPH R. JERUSALEM</td>
<td>Lab. of Cytology, University of Nijmegen, Netherlands. (Cytology)</td>
</tr>
</tbody>
</table>
52. CARL F. JORDAN
   Doctor of Science, Institute of Ecology, University of Georgia, Athens, USA.
   (Ecology)

53. NGUYEN DINH KHOA
   Candidate of Science, University of Hanoi, Vietnam.
   (Anthropology)

54. Prof. MITSUSHIRO KIDA
   M.D., School of Medicine, Teikyo University, Tokyo, Japan.
   (Teratology)

55. MIKHAIL F. KISSELJOV
   Doctor of Science, Research Institute of Biological Testing of Chemicals, Academy
   of Science, Moscow, USSR.
   (Biochemistry)

56. Prof. ALEXI F. KOLOMIETZ
   Institute of Organic Chemistry, Academy of Sciences, Moscow, USSR.
   (Chemistry)

57. JIRI KUCERA
   Doctor of Science, Institute for Mother and Child, Prague, Czechoslovakia.
   (Teratology)

58. VLADIMIR LANDA
   Academician, Institute of Entomology, Academy of Sciences, Prague, Czechoslovakia.
   (Entomology)

59. Prof. TON DUC LANG
   Dept of Anesthesiology, Viet-Duc Hospital, Hanoi, Vietnam.
   (Epidemiology)

60. BUI THI LANG
   Doctor of Science, Committee of Sc. and Tech. of Ho Chi Minh City, Vietnam.
   (Marine Biology)
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<th>No.</th>
<th>Name</th>
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<th>Discipline</th>
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<tr>
<td>61</td>
<td>PHAM DUY LINH</td>
<td>M.D., Vice-Director, Health Service of Ho Chi Minh City, Vietnam. (Epidemiology)</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Prof. MARK LEIGHTON</td>
<td>Dept. of Anthropology, Harvard University, Cambridge, USA. (Animal Ecology)</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>NGUYEN XUAN LOC</td>
<td>Doctor of Science, Institute of Mathematics, Hanoi, Vietnam. (Statistics)</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>OLEG M. LISSOV</td>
<td>Doctor of Science, Legal Office, Ministry of Defence, Moscow, USSR. (Chemistry)</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>ZBIIGNIEWS MAKLES</td>
<td>Doctor of Science, Dept. of Analytic Chemistry, Institute of Hygiene and Epidemiology, Warsaw, Poland (Analytic Chemistry)</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Prof. IVAN I. MARIAN DUDIN</td>
<td>State Committee of Forestry, Moscow, USSR. (Forestry)</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>LEV W. MEDVEDEV</td>
<td>Doctor of Science, Institute of Animal Morphology and Ecology, Moscow. USSR (Zoology)</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>BOGUSLAW MOLSKI</td>
<td>Doctor of Science, Botanical Garden, Academy of Science, Warsaw, Poland. (Forestry)</td>
<td></td>
</tr>
</tbody>
</table>
69. ISAO MOTOTANI  
Faculty of Agriculture,  
Tokyo University of Agriculture and Technology,  
Tokyo, Japan. (Animal Ecology)

70. Prof. SUSIL K. MUKHERJEE  
322 Jodhpur Park, Calcutta, India. (Soil Science)

71. Prof. NGUYEN DUY MINH  
Teacher-Training College No. 1, Hanoi, Vietnam. (Ecology)

72. MYSAMEDY  
M.D., Faculty of Med. and Phar., Phnom Penh, Kampuchea. (Radiology)

73. VJASCHEŠLAV V. NAZAROV  
Doctor of Science, Ministry of Fertilizers and Pesticides, Moscow, USSR. (Soil Science)

74. BUI VAN NGAC  
Candidate of Science, Ministry of Agriculture, Vietnam (Botany)

75. PHUNG TRUNG NGAN  
Ph. D., University of Ho Chi Minh City, Vietnam. (Ecology)

76. HO DANG NGUYEN  
M.D., Director of Tay Ninh Hospital, Vietnam. (Epidemiology)

77. Prof. KEES OLIÉ  
Laboratory of Environmental and Toxicological Chemistry, University of Amsterdam, Amsterdam, Netherlands. (Chemistry)
78. OM SOKHA
   M.D., Revolution Hospital, Phnom Penh, Kampuchea. (Medicine)

79. Prof. EGBERT W. PFEIFFER
   Dept. of Zoology, University of Montana, Missoula, USA. (Zoology)

80. JAROMIR POSPISIL
   Doctor of Science, Institute of Landscape Ecology, Academy of Sciences, Prague, Czechoslovakia. (Ecology)

81. PHAM HOANG PHIET
   M.D., Cho Ray Hospital, Ho Chi Minh City, Vietnam. (Immunology)

82. Prof. NGUYEN HUNG PHUC
   Medical College of Hanoi, Vietnam. (Pharmacy)

83. NGUYEN THI NGOC PHUONG
   M.D., Vice-Director, Gynecology and Obstetrics Hospital, Ho Chi Minh City, Vietnam. (Surgery)

84. YURI G. PUZACHENKO
   Doctor of Science, Institute of Animal Morphology and Ecology, Academy of Sciences, USSR. (Forest Ecology)

85. Prof. NGUYEN HUU QUANG
   Ministry of Forestry, Vietnam. (Forestry)

86. Prof. VO QUY
   University of Hanoi, Dept. of Biology, Vietnam. (Animal Ecology)

87. Prof. T. NAVANEETH RAO
   Dept. of Chemistry, Osmania University, Hyderabad, India. (Chemistry)
88. VANNARETH RAJPHO  
M.D., Ministry of Public Health, Vientiane, Laos.  
(Anatomy)

89. Prof. CHRISTOFFER RAPPER  
Dept. of Organic Chemistry, University of Umeå, Umeå, Sweden.  
(Organic Chemistry)

90. Prof. PAUL W. RICHARDS  
(Botany)

91. Prof. SLAWOMIR RUMP  
M.D., Dept. of Environmental Toxicology, Institute of Hygiene and Epidemiology, Warsaw, Poland.  
(Toxicology)

92. SAU SOK KHONN  
M.D., Director, 7—January Hospital, Phnom Penh, Kampuchea.  
(Medicine)

93. Prof. NATALIO S. SARAHAGER  
Institute of Medicine, Faculty of Medicine, Havana, Cuba.  
(Microbiology)

94. SENG IM NEOU  
Faculty of Medicine and Pharmacy, Phnom Penh, Kampuchea.  
(Pharmacy)

95. Prof. SAMUEL C. SNE-DAKER  
School of Marine Science, University of Miami, Miami, USA.  
(Marine Ecology)

96. VLADIMIR E SOKOLÓV  
Academician, Institute of Animal Morphology and Ecology, Academy of Sciences, Moscow, USSR.  
(Zoology)
<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Position/Institution</th>
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<tbody>
<tr>
<td>97.</td>
<td>SVETLANA SOKOLOVA</td>
<td>Doctor of Science, Main Botanical Garden, Academy of Sciences, Moscow, USSR. (Plant Biochemistry)</td>
</tr>
<tr>
<td>98.</td>
<td>Prof. THEODOR D. STERLING</td>
<td>Dept. of Computing Science, Simon Fraser University, Burnaby, Canada. (Biochemistry)</td>
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<td>99.</td>
<td>Prof. DANG NHU TAI</td>
<td>Dept. of Chemistry, University of Hanoi, Vietnam. (Organic Chemistry)</td>
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<td>100.</td>
<td>ARMEN L. TAKHTAJAN</td>
<td>Academician, Komarov Botanical Institute, Leningrad, USSR. (Botany)</td>
</tr>
<tr>
<td>101.</td>
<td>Prof. PHAM BIEU TAM</td>
<td>M.D., Binh Dan Hospital, Ho Chi Minh City, Vietnam. (Surgery)</td>
</tr>
<tr>
<td>102.</td>
<td>CHANPHENG THAM-MAVONG</td>
<td>M.D., Mahosot Hospital, Vientiane, Laos. (Surgery)</td>
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<tr>
<td>103.</td>
<td>Prof. HO SI THOANG</td>
<td>Director of Institute of Chemistry, Vietnam. (Chemistry)</td>
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<td>104.</td>
<td>Prof. TRAN THE THONG</td>
<td>State Commission of Science Research, Vietnam. (Zoology)</td>
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<td>105.</td>
<td>Prof. LE VAN THOI</td>
<td>University of Ho Chi Minh City, Vietnam. (Chemistry)</td>
</tr>
<tr>
<td>106.</td>
<td>TRAN XUAN THU</td>
<td>Candidate of Science, Dept. of Organic Chemistry, University of Hanoi, Vietnam. (Chemistry)</td>
</tr>
</tbody>
</table>
127. Prof. MAI DINH YEN
Dept. of Biology, University of Hanoi, Vietnam. (Zoology)

128. Prof. PAUL J. ZINKE
Dept. of Forestry and Resource Management, University of California, Berkeley, USA. (Soil Science)
OBSERVERS

1. MOHAMED S. BOULE-CANE
2. BOUNSOULING BOUAPHENG
3. SOUMPHOLPHALDY BOUNTHEUNG
4. PHUNG TU BOI
5. DANG SANG CANH
6. NGUYEN XUAN CU
7. DO BINH DUONG
8. JOHN R.E. HARGER
9. VU MINH HANG
10. DINH HIEP
11. VI NGUYET HO (Mrs Ton Thanh Tung)
12. NGUYEN DUC KHANG
13. TRINH VAN KHIEM
14. Professor SUDITH LADINSKY

FAO, (Agriculture), Hanoi, Vietnam
Laos
Laos
(Forestry), Vietnam
M.D., Vietnam
(Biology), Vietnam
(Gynecology-obstetrics), Vietnam
Doctor of Science, UNESCO, Djakarta, Indonesia
(Forestry), Vietnam
(Forestry), Vietnam
(Anesthesia), Vietnam
(Forestry), Vietnam
M.D., (Epidemiology), Vietnam
Dept. of Preventive Medicine, University of Wisconsin, Madison, USA
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<td>15</td>
<td>REYNALDO M. LESACA</td>
<td>Doctor of Science, UNEP (Environmental Science), Bangkok, Thailand</td>
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<td>16</td>
<td>NGUYEN LIEN</td>
<td>M.D., Vietnam</td>
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<td>17</td>
<td>JOHN H. LEVAN</td>
<td>M.D., Dept of Radiology, Chicago Medical School, North Chicago, USA</td>
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<td>18</td>
<td>JOHN H. LEVINSON</td>
<td>M.D., Aid for Int. Medicine, Wilmington, USA</td>
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<td>19</td>
<td>SYSOUVANES BOUN LOUANE</td>
<td>Laos</td>
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<td>20</td>
<td>Professor DOAN XUAN MUOU</td>
<td>M.D., (Microbiology), Vietnam</td>
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<td>21</td>
<td>PHAM NGOC QUE</td>
<td>M.D., Ministry of Health, Vietnam</td>
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<td>22</td>
<td>NGUYEN XUAN QUYNH</td>
<td>Teacher-Training College, Hanoi, Vietnam</td>
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<td>23</td>
<td>CAO VAN SUNG</td>
<td>Candidate of Science (Animal ecology), Vietnam</td>
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<td>24</td>
<td>Professor TRINH VAN THINH</td>
<td>(Agriculture), Vietnam</td>
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<td>26</td>
<td>NGUYEN KIM TONG</td>
<td>M.D., (Gynecology-obstetrics), Vietnam</td>
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<td>27</td>
<td>VU HOAI TUAN</td>
<td>Candidate of Science, (Chemistry), Vietnam</td>
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<td>28</td>
<td>TRAN THI THAI</td>
<td>M.D., (Genetics), Vietnam</td>
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<td>29</td>
<td>NGUYEN HOANG TRI</td>
<td>Candidate of Science, (Ecology), Vietnam</td>
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<td>30</td>
<td>NGUYEN VAN TRINH</td>
<td>M.D., Vietnam</td>
</tr>
<tr>
<td>31</td>
<td>NGUYEN DINH VINH</td>
<td>(Forestry), Vietnam</td>
</tr>
</tbody>
</table>
WORKING GROUPS ASSIGNMENTS

Plant Ecology
- Thai Van Trung (Chair)
- Hoang Hoe (Vice-Chair)

Animal Ecology
- Vo Quy (Chair)
- Dang Huy Huynh (Vice-Chair)

Soil Ecology
- Hoang Van Huay (Chair)
- Le Trong Cuc (Vice-Chair)

Coastal and Aquatic Ecology
- Mai Dinh Yen (Chair)
- Bui Thi Lang (Vice-Chair)

Cancer and Clinical Epidemiology
- Pham Bieu Tam (Chair)
- Luong Tan Truong (Vice-Chair)

Reproductive Epidemiology
- Nguyen Can (Chair)
- Nguyen Thi Ngoc Phuong (Vice-Chair)

Experimental Toxicology and Chemistry
- Cung Binh Trung (Chair)
- Bach Quoc Tuyen (Vice-Chair)

A. W. Galston (rapporteur)
E. W. Pfeiffer (rapporteur)
P. J. Zinke (rapporteur)
S. C. Snedaker (rapporteur)
S. S. Epstein (rapporteur)
J. D. Constable (rapporteur)
A. Hay (rapporteur)