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War, Genetics and the Law

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War is an instance of acute environmental degradation. It has progressed in this century from a phenomenon of discrete personal encounters to one of gross undifferentiating devastation made possible by the advent of chemical and biological weaponry. Defoliation is one widely publicized aspect of war’s impact on the environment. War’s effect on genetics and the potential of life to reproduce itself is just beginning to be recognized. In this Perspective, the authors argue that if there is to be a meaningful attempt to regulate war and to mitigate its effects, then consideration must be given to war as an ecologically and, in particular, genetically destructive process. The authors’ argument concerning the control of new technologies with only partially understood effects echoes an issue that is practically universal throughout the environmental field, whether the problem be pesticides or the proliferation of nuclear power plants. Because of its intensity and acuteness, war offers a case-study of an environmental problem, one which those concerned with environmental quality cannot afford to ignore.

The present concern about war both in Indochina and the Middle East is in essence a part of the more general concern for ecology. As man’s genius develops new weaponry with greater destructive efficiency the age-old question of war addresses itself not solely to the moral issue of man killing man, but now to the possible extinction of the human species and of the biological environment which sustains life. A basic question before the community of man is whether or not his legal genius can adequately educate and channel his scientific inventiveness before total annihilation takes place. It is with this basic question that this Perspective is concerned.

Part I sets this inquiry in its context of urgency and anomaly, and stresses the novel and severe threats to the world environment that issue from recent technological innovations in warfare. Part II reviews the genetic effects of war upon the sustenance and stability of life, and underscores the stark necessity for inhibiting those effects by con-
trol of weapons use and development. Part III considers applications and limitations of legal tools in the search for this essential control.

I

CONTEMPORARY WARFARE

There are certain characteristics of the group of weapons, which will here be termed "chemical"\(^1\) and "biological,"\(^2\) which logically lift them from the historical and descriptive continua traditional in discussions about war, and which require that they be studied separately. These characteristics include unprecedented temporal longevity and geographic range, as well as relatively unknown and widely unanticipated macrobiological, ecological and genetic impacts. A complex set of causal questions also necessarily surrounds the deployment of these weapons.

The use of these weapons is furthermore anthropologically and psychologically distinguishable from pre-twentieth century uses. While development from fists to sharp objects to airplanes to chemical and biological combinations may appear incremental (a matter of degree), the increased distance between attacker and attacked which chemical and biological weapons enable and the latent effects afforded by air attack constitute a revolutionary psychological difference between present and past modes of warfare.

In fact, of course, many persons on a given side of a given war of this century are in close proximity to one another, during battle and otherwise. But the actualities of mustard gas and firebombings in World War I, the atomic bombing of Hiroshima and Nagasaki in World War II, and the use of defoliants, tear and nausea gases, napalm and white phosphorus in Indochina during the Indochinese War, as well as the potentialities of nuclear, biological (bacteriological) and total chemical warfare make this revolutionary psychological difference a current reality.

The potential for psychological insensitivity\(^3\) which is enhanced by long-range and impersonal weaponry corresponds to an escalating potential for ecological and genetic changes. In turn, sensitivity to-

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1. See text at appendix A, *infra*.
2. See text at appendix B, *infra*.
3. But cursed are dullards whom no cannon stuns...

By choice they made themselves immune
To pity and whatever moans in man
Before the last sea and the hapless stars;
Whatever mourns when many leave these shores;
Whatever shares
The eternal reciprocity of tears.

ward those changes has become muted. In creating legal principles to circumscribe this peculiar potential of contemporary warfare, considerations must be given to the relationships between ecosystems and genes as targets which the chemical and biological weapons strike and alter. In order that the law may serve to engineer and to educate, as well as to regulate society, any discussion must be oriented toward the future and must encompass knowledge of projected environmental hazards that increase with each new scientific manipulation of war’s implements.

II

GENETIC EFFECTS OF WAR ON HUMAN POPULATION

A. Genetic Effects of Conventional War

Although the science of genetics has made great strides even within the past few decades little information is available on the genetic effects of conventional war. This is because few studies were done

4. In order to understand genetic effects of war weaponry, one should comprehend the relationship of mutation to organic life. Mutations are “errors” in gene production; the capacity for mutation is essential to organic evolution. G. SIMPSON, et al., LIFE: AN INTRODUCTION TO BIOLOGY 321-22 (1957). The value of a given mutation depends upon its biological context as well as the dynamics of the environment in which it occurs. Simply, a “mutagenic” substance can affect any life which is dependent upon genes for its structures, at any stage, from the most “potential” (germ cells) to the most “actual” (living organisms). Furthermore, a substance’s mutagenic propensities depend upon the manner and rate of exposure of the substance to the life or pre-life form. See, e.g., the discussion of the ever-present mutagenic character of ionizing radiation, and the variation of its effects depending on its quantity, distribution, type of exposure, and timing, in Reynolds, Irradiation and Human Evolution, in THE SUBVERSIVE SCIENCE 296-311 (P. Shepard & D. McKinley eds. 1969).

Many genes can affect a single characteristic of a life form—skin color, intelligence—and a mutation can affect the structure or number of genes as well as the DNA of which the genes are composed. G. SIMPSON, et al., supra at 322-24, 330. Environment affects gene action and vice versa. Id. at 333-34. Considering the “mutagenic” propensities of weapons in this context, the incompleteness of straight-line causal propositions becomes obvious: in the genetic effects of warfare, neither “nature” nor “nurture” works alone. The inadequacy of straight-line causal propositions in genetics forms the basis of the “interactionist” hypothesis: the characteristics of organism behavior are caused by interaction of genetic and environmental factors. See e.g., Birch, Boldness and Judgment in Behaviour Genetics, in SCIENCE AND THE CONCEPT OF RACE 50 (M. Mead, et al., eds. 1968). Presuming the interaction of nature and nurture in any given “genetic” phenomenon, the term “genetic” in this Perspective suggests an oversimple and straight-line causal model, and implies more understanding of causation in the genetics of chemical and biological weaponry than is actually available.

5. V. MCKUSICK, HUMAN GENETICS 1-3 (2d ed. 1969).

6. “Conventional” here refers to war which lacks the potential for ecocide or genocide identified in the Introduction. Admittedly, this usage ignores the incremental development of weapons by man within a given war, or between cultures or
on this subject after the First and Second World Wars.\(^7\) Other than general, abstractive, a priori and consequently unreliable projections concerning a general decrease in population due to the massive death of the young and the loss to the gene pool resulting therefrom,\(^8\) nothing of a truly scientific nature has been established regarding the genetic effects of conventional war. Therefore, little more than generalized projections can be made concerning the genetic effects of conventional war upon certain national populations and upon the world population in general.

However, it can be asserted that the death of any human being has actual and potential genetic effects. At the individual level of description, war does not seem to have distinctive genetic effects, when it is regarded as but another source of death-risks among human populations, along with disease, accident, meteorological and geological cataclysms, and “natural” degeneration. But, to whatever extent “race” is considered genetic, “race”-targeted wars have distinctive genetic effects, even where genetic characterizations of race are scientifically inaccurate. That is, because a popularly perceived “race” may not constitute a genetically distinct group, genocide may begin the eyes of onlookers who are isolating a culture rather than a “race” in their perceptions.

Once certain events are termed “genetic” beyond the subjective sense already noted, the meaning of that term in describing war-related changes remains difficult to ascertain. Given the multivariate interaction of nature and nurture surrounding any so-called genetic phenomenon,\(^9\) the term “genetic,” as used in this discussion, to modify the effects and risks of certain chemical and biological weapons, suggests a grossly oversimplified model of causation. To term a physical event “genetic” implies a greater understanding of the pat-

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\(^7\) The unsupported hypotheses of geneticist McKusick, *supra* note 5, at 195, regarding the relation of genetics to conventional warfare, are a function of this paucity of post-war studies of that relation. A thorough search of the relevant indexes in the Biology Library at the University of California, Berkeley, resulted in the retrieval of but one piece on the subject, consisting of an unpublished thesis devoted to speculation without any quantitative data about a possible relation between the numbers of persons killed in World War I and sex ratios of the offspring of the remaining populations.


\(^9\) See note 4 *supra*. 
terns of causation associated with warfare than is available based upon even the most thoroughly studied chemical and biological weapons.

For example, the genetic impacts of mustard gas, namely the stimulation of chromosomal breakages and atypical reunions, are to this day not fully understood. A logical link, between data demonstrating chromosomal aberrations among Drosophila correlative to certain dosages of mustard gas and studies demonstrating “significantly increased incidence of cancer in the respiratory tract (mainly lung) . . . among workers employed in the manufacture of mustard gas during World War II,” can only be presumed. It has not been demonstrated that the Drosophila results translate significantly to humans. Even with the amount of time and the intensity of the focus spent upon the genetic effects of mustard gas, the fact that there is as much data as the above brief statement suggests is somewhat unusual. Additionally, mustard gas is distinguishable from those chemical and biological weapons more recently developed or used, with respect to the higher quality and quantity of studies addressed to the genetic relationships of mustard gas exposures to life.

B. Genetic Effects of Nuclear Warfare

Because of the drastic revolution in weaponry demonstrated at Hiroshima and Nagasaki, it would be reasonable to expect that much more information has been synthesized regarding the genetic effects of this new nuclear weaponry than has been ascertained with respect to conventional weaponry. Because of the limited wartime use of this weaponry and the resulting controlled areas for statistical investigation and research, it could likewise be expected that more mathematized and less generalized genetic information would be available than with conventional weaponry. However, genetic research has been limited because of the relatively short time since the atomic bomb fell on those cities. Time for the development of gene pools and hybrids is essential to assess the validity and reliability of findings. Therefore, most of the information respecting the effect of radiation on gene pools has been achieved through laboratory experi-

11. Drosophila are fruit flies; they have played a major role in the testing of genetic hypotheses. G. Simpson, et al., supra note 4, at 323-25.
14. See A. Loveless, supra note 10, at 114-17, noting the lack of data available on such induced mutations in mammals, and thus man.
mentation, rather than through observation of the contaminated populations of Hiroshima and Nagasaki.15

Both gene mutations and gross chromosomal anomalies may be caused by the introduction of dosages of ionizing radiation into the environments of living things. Gene mutations consist of the alteration of single genes, while chromosomal anomalies involve rearrangement of the genetic message of DNA by transposition elimination or repetition in points of the genetic code. Laboratory work has correlated both types of genetic change with radiation exposure.16

Documentation of the radiation linkages of gene mutation in human beings may be extrapolated from experiments upon infra-human animals and plants. For example, from studies on mice, geneticists have ascertained that the frequency of gene mutations increases in direct proportion to increases in radiation dosage. Furthermore, an instantaneous dosage upon a mice sample results in relatively higher frequency of gene mutations than does a temporally gradated dosage.17

Experiments using mice provide only a general description of the quantitative relations between timing, volume and frequency of dosage, on the one hand, and frequency of gene mutations on the other. These experiments do not provide direct and species-specific data as to the quantitative relations of radiation dosage to human gene mutations. Due to physiological and ecological limitations upon the mice-man analogy, estimates of the total number of human gene variations to be anticipated among irradiated parent populations and among their offspring vary widely and are subject to multiplication of original errors in estimates.18

Relatively more specific evidence of the quantitative relations between radiation dosage and frequencies of gross chromosomal anomalies is available at present. This is attributable to the ability of technicians to observe gross chromosomal anomalies induced by

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16. Id. See also, Muller, Genetic Damage Produced by Radiation, SCIENCE, Aug. 10, 1955, at 837-40.
radiation exposure directly in the soma of human beings.\textsuperscript{19} Observation of human and infrahuman tissues for purposes of documenting the interaction of radiation with chromosomal matter has substantiated a dependency of the phenomena of gross chromosomal anomalies upon radiation dosage. But the relation is more complex than that of direct proportion, unlike the radiation-gene mutation relationship.

Because of the considerable complexity of the radiation-chromosome anomalies relationship, estimates of the probable rate of gross chromosomal anomalies in offspring of irradiated parents are shrouded in statistical invalidity and unreliability. The precise quantitative relation between certain common chromosomal anomalies and radiation is inestimable, although somewhat more accurate estimates of that relation in situations of anomalies linked with severe somatic defects may be established.\textsuperscript{20} Overall, the limitations upon precision of these estimates makes analysis of multi-generational radiation effects scientifically impossible.

The state of causal propositions about radiation-genetic interactions is quite telling, in its suggestion of some of the difficulties of studying and determining the effects of arsenic-genetic, cyanide-genetic, or carbon monoxide-genetic interactions which have occurred and are occurring in Vietnam. The state of knowledge in the radiation-genetic realm has been described by evolutionary anthropologist Earle Reynolds as follows:

\begin{quote}
It is generally accepted that there is a lineal relation between gonadal radiation and mutation, that even the smallest dose may have genetic effects, that the consequences are cumulative, and that there is no recovery. Mutations are considered to be usually deleterious.
\end{quote}

\textsuperscript{* * *}

Having said this, we must make the startling confession that there is, in man, “no completely convincing evidence that mutations are induced by radiation” . . . this area is one of the most actively discussed topics in human biology; furthermore, the biological effects of radiation appear to be one of those unhappy subjects, wherein the more we learn, the less we like it.\textsuperscript{21}

The relevance of the experience with, and knowledge about, radiation to the analysis of chemical weaponry lies in the making of predic-
tions about prediction-making. That is, the radiation, mustard gas and pesticide experiences suggest certain guidelines for persons interested in preventive measures to be posited upon the potential harms of nuclear weaponry.

The experience of this Earth with radiation must serve to offer at least a cautionary analogy to the makers and users of chemical and biological weaponry. By far the most significant feature of that accumulated experience with radiation lies in the fact that radiation-induced alterations in hereditary determinants are actualized exponentially over spans of time. At first, radiation-induced changes are necessarily invisible, occurring as they must in genes and chromosomes. Technical and moral inhibitions upon total laboratory observation of such changes in humans are but a contributing factor in the initial invisibility of these radiation-linked phenomena. The temporally exponential nature of genetic effects provides a continuing blind against observation of the specific causal propensities involved in radiation exposure and their realization in successive generations. Potentials for defects may not manifest themselves for several generations, unless or until the death of an entire generation demonstrates the lethal potentials created by an initial exposure many years before.\(^2\)

Worldwide research is necessary for establishment of detailed and eco-specific causal propositions about radiation in life. But such research is inhibited by the constraints upon international scientific institutions and by a multiplicity of related military and political factors, as well as by the cumulative nature of the phenomena discussed above. One proposition may nonetheless be offered, to persons concerned with the analogy between radiation and other chemical and biological substances used as weapons, with reasonable certainty: Any population that has been irradiated at any intensity sufficient to kill even a small percentage of its members would suffer important longterm consequences affecting great numbers of individuals.\(^3\)

C. Genetic Effects of Chemical Warfare

The use of chemical weaponry by United States and South Vietnamese forces in Vietnam will serve as a prototype of discussion of these weapons' short-, mediate-, and long-term genetic effects. Discussion of the legal obstacles to be faced in the prohibition or control of chemical warfare will follow this scientific description of that prototype.

The United States Department of Defense may or may not know the amount and physical extent of chemical weapons used in Vietnam

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22. Id.; see also, U.N., Effects of Nuclear Weapons, supra note 15, at 52.
since United States intervention in 1962. Even if known, these facts remain inaccessible to the public at large. Reliance upon second-hand reports is therefore necessary in this discussion, and the limitations upon these sources of data must be kept in mind. Since the risks caused by chemical weapons vary with the quantity used and geographic range affected, the particular harm done and risks run in Vietnam can only be estimated. Finally, there is nearly a total lack of studies addressed to the effects of chemical weaponry on the populace and land mass of Vietnam. Therefore, analogy and inference must be indulged. In any case, certain latent effects, particularly genetic ones, would probably not be perceived through such studies at this time.

A necessarily incomplete compilation of data regarding each of the chemical weapons used in Indochina follows. The greatest danger of this presentation, which is far more serious than its necessary incompleteness, is that it suggests a separation of the chemical elements which distorts the fact of their mutual presence and interaction with the life forms and ecosystems of Vietnam.

1. **CN, CS, and DM**

Chloroacetophenone (CN) and ortho-chlorobenzylidene malononitrile (CS), generally termed “lacrimators” and “harassing agents,”

25. Id. at 95.
26. See generally, Reynolds, supra note 4, at 300, noting the need to study the effects of such exposure over several generations; see also Woodwell, et al., A-Bombs, Bugbombs, and Us, in THE SUBVERSIVE SCIENCE, 235-36 (P. Shepard & D. McKinley eds. 1969), discussing long-range health hazards.
27. See text at note 23, supra.

However, a recent study by the American Association for the Advancement of Science strongly corroborates the inference offered here regarding a correlation between herbicide use and increases in birth defects in the offspring of the exposed female population, although scientists in that study were, for no apparent reason, unwilling to make the causal inference. The authors of the study said that it would be necessary to consider other factors in a larger study and that it was “totally incorrect” to attribute all of the increase to the use of herbicides although conceding that there were more stillbirths than normal. See, Herbicides in Vietnam: AAAS Study Finds Widespread Devastation, SCIENCE, Jan. 8, 1971, at 43-47.

28. See text at appendix A, infra, for an analysis of the ecocidal effects of U.S. use of defoliants and incendiaries. For witnesses’ first-hand accounts and photographs from South Vietnam, see B. WEISBERG, ECOCIDE IN INDOCHINA: THE ECOLOGY OF WAR (1970). Mr. Weisberg’s viewpoint as to the merit and ethics of further scientific assessment of the damage in Indochina bears emphasis:

Can we, after the war (if that can be imagined), with any respect to the people we have devastated, send our teams of scientists and social engineers into Indochina to patch up the damage: to study the Vietnamese as we did the Japanese after Hiroshima?

Id. at 13. The problems encountered in adapting scientific inferences to legal analysis are discussed in part III, B & C, infra.

29. See, e.g., A. PRENTISS, CHEMICALS IN WAR 263 (1937); M. JACOBS, WAR GASES 10-11 (1942).
have lethal indices which can cause death among those who, because of age, poor health, or continuity of exposure, are rendered sensitive to their lethal character despite their less-than-lethal effects on the “average” victim. A United States Army manual provides that adamsite (DM), commonly termed a “sternutator” and an “harassing agent,” should not be used “where deaths are not acceptable.”

The ordinary nonlethal effects of adamsite (DM) include head and chest pain, eye and nose irritation, and vomiting. The use of adamsite in the Indochinese War by the United States forces has had a politically splotchy history, because of some protests against it in the United States and a reported loss of international prestige by the United States Information Agency, among other factors.

The vomiting associated with adamsite is due to one of its main components, arsenic, which poses the risk of systemic arsenical poisoning in man and other animals, and of the poisoning of ecosystemic chains, including food chains, by infiltrating water supplies and the soil. The classification of adamsite as an “harassing” rather than a “lethal” or “casualty” agent is therefore markedly arbitrary. This classification tends to conceal adamsite’s short- and long-term death risks for that class of persons who are too old, young, sick, or dependent upon poisoned water and food supplies to have an “average” reaction to adamsite.

2. 2,4-D; 2,4,5-T; and Cacodylic Acid

The best-known effects of the use of herbicides and defoliants in Vietnam are the destruction of crops and the effective destruction of the soil on which the crops and forests stood. While the figures cannot be stated with accuracy, a 1967 Japanese study placed the extent of ruined land in South Vietnam at 3.8 million acres, approximately forty-seven percent of the food-producing acreage of that country.

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30. U.N., Chemical and Bacteriological Weapons, supra note 13, at 45; S. Hersh, Chemical and Biological Warfare 60 (1969).
32. A. Prentiss, supra note 29, at 263; S. Hersh, supra note 30, at xii.
33. S. Hersh, supra note 30, at 62, citing Field Manual 3-10, Employment of Chemical and Biological Agents (Dep’t of the Army Publication, Mar. 1966).
34. A. Prentiss, supra note 29, at 214; S. Hersh, supra note 30, at xii.
35. S. Hersh, supra note 30, at 168-71.
36. Id. at 184-85, citing B. McNamara, Special Publication 2-31, Edgewood Arsenal (1960); M. Jacobs, supra note 29, at 29-30, 51, 156.
37. Cf. Woodwell, et al., supra note 26, at 235-40, concerning concentrations of poisons in the food chain. The Woodwell article, discusses poison concentrations where the source of toxicity is pesticides. Similar results can be expected from poisonous gases.
38. S. Hersh, supra note 30, at 153-54.
The estimates of other sources are more modest. The United States has disclaimed these findings of the Japanese study, as "sheer propaganda,"39 without offering any contravening proof. Other immediate effects of these cremicals, which apparently depend upon the amount used and the health and age of the victim, as well as proximity and mode of ingestion, include systemic toxicity and, in the case of cacodylic acid, arsenical poisoning40 of humans and animals.

In identifying the mediate- and long-term effects of these herbicides and defoliants on man and ecosystems, the best available analogy is to the American experience with pesticides and weed-killers. Regarding the potential genetic effects of pesticides, scientists at Brookhaven National Laboratory working under the Atomic Energy Commission have determined that:

Pesticides are intensely poisonous, and must be poisonous to control pest effectively. There is little evidence now that they produce cancer or are (except for special cases of extreme exposure) damaging to health. But it is certainly not true that hazard to man is unlikely. It is more accurate to say, first, that we do not know now the long-range hazard of pesticides and, second, that analogies with radioisotopes and cancer-producing substances in cigarette smoke and atmospheric pollution suggest we are likely to encounter unpleasant surprises.41

One Vietnamese doctor has reported that among persons who had touched the defoliated areas or breathed the air around them or both, there were some cases of blindness and of stillborn or premature births among pregnant women.42 In this respect, perhaps these people constituted "cases of extreme exposure" or perhaps the amount and extent of defoliants and herbicides used in South Vietnam makes these effects "average" for that chemically inundated area.

Long-term ecological effects for the land of South Vietnam, especially in high rainfall areas, include the possibility of mosquito nourishment due to erosion and the formation of pools of stagnant water. United Nations materials pertinent to this situation state simply that "[d]eserts have been created in this way."43

39. Id. at 154.
40. Id. at xii-xiii, 101-02, 164; D'Amato, et al., supra note 31, at 1096.
41. See, Woodwell, et al., supra note 26, at 235-36; see also U.N., Chemical and Bacteriological Weapons, supra note 13, at 86, 92.
42. S. Hersh, supra note 30, at 157; see also B. Weisberg, supra note 28, at 61.
43. U.N., Chemical and Bacteriological Weapons, supra note 13, at 95; see also authorities cited in notes 26 & 28, supra; B. Weisberg, supra note 28, at 71. What the printed findings of most studies omit is shown strikingly in the photographs in Ecocide. The nature and extent of ecological destruction in Indochina is more immediately perceptible from examination of Mr. Weisberg's collection.
3. **Napalm and White Phosphorus**

Napalm and white phosphorous are generally classified as "incendiary devices." As with the classification of CS, CN and DM as "harassing agents," and for 2,4-D and 2,4,5-T as "defoliants," this label is highly deceptive. In fact, white phosphorus "does not have much value as an incendiary . . . it forms a fire-proof coat of phosphoric acid." However, white phosphorus gives off poisonous vapors, and "[i]n contact with the body," phosphorous produces "painful burns that are slow and difficult to heal; thus the firing of phosphorus against personnel has a psychological value that greatly increases its tactical effectiveness." In light of its poor incendiary qualities except as to living matter, the label "incendiary" should be replaced with that of "flesh-incendiary" as a matter of scientific accuracy.

In 1968 in the United States, napalm was being produced at the rate of nearly fifty million pounds per month. Napalm is essentially jellied gasoline; where it does not kill, it produces burns which are terribly debilitating and painful, especially to children. Furthermore, napalm gives off carbon monoxide when burning, thus being "at least equally effective in terms of the number of victims killed or injured (by asphyxiation) as the direct burning by napalm itself."

**D. Genetic Effects of Biological Warfare**

Together with the spectre of nuclear and chemical warfare, there is developing at an alarming rate biological (bacteriological) weaponry that could conceivably effect drastic genetic and carcinogenic changes in man and his environment. There is a growing list of biological agents which could be used as lethal or debilitating weaponry. According to a report made in 1969 by the Secretary-General of the

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44. S. Hersh, supra note 30, at 53; A. Prentiss, supra note 29, at 48-49, 251.
45. M. Jacobs, supra note 29, at 42.
46. A. Prentiss, supra note 29, at 235, 251.
47. S. Hersh, supra note 30, at 54.
49. S. Hersh, supra note 30, at 54-55. Dr. George Roth, a member of the Committee of Responsibility which arranges for medical care in the United States for a few war-injured children, corroborates the description of the widespread use of napalm in South Vietnam and its disproportionately horrifying effects upon the children for whom he has cared. See Dr. Roth's description and that of William F. Pepper of the Commission on Human Rights, in B. Weisberg, supra note 28, at 109, 163-68.
51. See Appendix B.
United Nations, a number of biological agents carry the potential of being developed by geneticists into effective biological weaponry. Genetic manipulation of these agents or chemical manipulation of their nucleic acids might be used to acquire strains of ever increasing virulence and greater resistance to environmental stresses. Among the viruses, those which could be so engineered to have greater virulence and more refined immunological characteristics include such death-causing viruses as Eastern equine encephalitis, tick-borne encephalitis, yellow fever, and such incapacitating viruses as Chikungunya, Dengue fever, and Venezuelan equine encephalitis. The scientific literature available at this time indicates that research into the genetics of rickettsiae has been less intense than into that of viruses and bacteria. Nevertheless the use of death-causing viruses, including Rocky Mountain spotted fever and epidemic typhus, together with the incapacitating rickettsia Q fever, are not only possible but imminent. From the available data, which of course remain highly restricted, it appears that most of the genetic research for the development of biological weaponry is taking place in the discovery and development of new strains of bacteria. Of course many pathogenic bacteria are susceptible to antibiotic drugs, but antibiotic-resistant strains occur naturally and can be used as effective means for contamination. Besides discovery of naturally occurring antibiotic-resistant strains, geneticists can select or obtain these strains through genetic manipulation. Similarly, it is possible to select strains with increased resistance to inactivation by sunlight and drying, a necessary trait if the bacteria are to be used as effective weapons. Among the death-causing bacteria capable of these kinds of developments are included anthrax, cholera, plague, pneumonia, tularaemia, typhoid, and among the incapacitating bacteria is included brucellosis.

To ascertain the genetic effects of these new biological forms of weaponry is more difficult than to isolate the effects of chemical wea-

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52. U.N., Chemical and Bacteriological Weapons, supra note 13, at 2.
53. See Id. at 59, 62-63, 69. Information on research developments after 1969 is very scarce.
54. For fuller description of the symptoms of these diseases, see id. at 51-55.
55. Id. at 17.
56. Id.
57. See S. Hersh, supra note 30, at 73-78.
58. There are many methods for altering resistance or transferring hereditary factors (such as insensitivity to antibiotics) from one bacterium or virus to another. These range from a simple method of conditioning to a complicated genetic interchange known as "recombination." The result of this latter method is to spread the resistance factors (R factors) from germ to germ by actual transfer of genetic material. See generally, U.N., Chemical and Bacteriological Weapons, supra note 13, at ¶ 15.
59. Id. at 50-55.
pons. One of the main factors preventing such a determination of the
genetic effects of biological weaponry has been the lack of any known
prototype comparable to the Indochinese War with respect to chemi-
cals upon which research might be based. Genetic projections rele-
vant to biological warfare depend more on general genetic theory, lab-
oratory experimentation and extrapolation. However difficult it may
be to make these projections with accuracy and specificity, it is com-
monly agreed that two general genetic effects would result from any ex-
tended use of biological weapons.

First, from the present status of genetic knowledge, the sound
hypothesis arises that large-scale use of biological weapons could easily
reduce populations of susceptible species below the level at which they
could continue to exist. This elimination of one or more species would
create lacunae in the ecological community that might seriously threaten
the ecological equilibrium. Alternatively, these lacunae might be
filled by other species more deleterious to man because they carried
a zoonosis infection acquired either naturally or as a result of the
original attack, and this event could in turn result in the establishment
of new natural foci of disease.

The second long-term hazard frequently projected by microbiolo-
gists is that, through the use of biological weaponry, strains of organ-
isms of altered immunological characteristics or increased virulence
could be established. As large numbers of humans or other suscepti-
ble animal species become infected through biological attack there is
provided the opportunity for new and mutagenic germ strains to arise
naturally. This is illustrated by the appearance from time to time
of immunologically different forms of influenza viruses. It is well-
known that with massive development of bacteria resistance transfer
factors are developed and are easily transferred to other bacteria. The
altered forms of infectious agents which would be used in a bacteriologi-
cal attack could therefore easily cause more severe and perhaps more
widespread epidemics than the original attackers had anticipated.

These two effects are interrelated, and their description is neces-
sarily general, because there has been no known use of these agents.
As a result a more particularized knowledge of genetic effects, unlike
the chemicals, is virtually impossible to gather. The most specific in-
formation concerning the genetic effects of biological warfare seems

60. U.N., Chemical and Bacteriological Weapons, supra note 13, at 73.
61. Id.
62. Id. at 74.
63. Id.
64. Id. at 51.
to cluster in the area of the almost certain development of new strains of organisms of altered immunological characteristics.

E. Genetics in the Creation of Biological Weaponry

A number of related research projects have been undertaken in the development of new biological warfare techniques. These projects can be generally classified into five categories: (1) development of transportation systems, including airplanes, missiles, and espionage instruments, which can most easily and effectively transport the viruses, rickettsiae, bacteria, fungi, protozoa or parasitic worms to the enemy territory for efficient contamination; (2) fabrication of packaging which will do the least harm to the virulent agents and allow them to be most effective in the contamination of life; (3) a search for and creation of the most virulent and antibiotic-resistant germ agents; (4) development of processes of production of these highly virulent germ agents; and (5) development of methods of storage for these agents so that they will remain alive, virulent and easily transportable when required. The science of genetics is primarily concerned with the third of these investigations, although warfare geneticists must always remain mindful of the second, fourth and fifth projects as well.

In developing biological warfare agents, geneticists concern themselves with discovering and growing viral, bacterial, rickettsial, fungi, protozoan and parasitic worm strains which have characteristics that are particularly conducive to being used as lethal or debilitating weapons. These characteristics include high infectiousness, easy reproduction, high percentage of viability and sufficient stability to meet military needs. A close study of the genetic research being done in the past five years by the United States Army Chemical Corps at its biological weaponry center at Fort Detrick, Maryland, indicates that the biological agents developed up to 1968 for germ warfare included four bacterial diseases: tularemia, brucellosis, plague and anthrax; and three viral diseases: psittacosis, Rift Valley fever and Rocky Mountain spotted fever. The present goal of geneticists working in this field is to develop strains of these diseases highly resistant to antibiotics so that existing and even foreseeable inoculants will be unable to stem an epi-

65. This involves the development of the processes of lyophilization (freezing and drying process of certain biologicals which are normally grown in liquids for purposes of storage), and micro-encapsulation (the coating of each biological particle with a wall material such as gelatin or any one of a variety of synthetic polymers for effective storage). Id. at 107.

66. S. Hersh, supra note 30, at 75.

67. Id. at 88-92; see text at appendix B, infra, for a summary description of the effects of such diseases.
demic once the enemy has been infected by them. Geneticists involved in this research are also developing new strains of viruses, rickettsiae, and bacteria which will have the qualities to make them more effective biological warefare agents, such as escalating intensity of infection, easy reproduction and an increased resistance to inactivation by sunlight and drying by developing strains which are susceptible to lyophilization and micro-encapsulation.

In testimony given before a congressional subcommittee on appropriation in 1963, Major General Marshall Stubbs of the Army Chemical Corps reported that

[a]: the United States Army Biological Laboratories genetic studies of microorganisms—bacteria, viruses, rickettsiae and fungi—are receiving ever-increasing attention. Attention is devoted to basic studies in genetics to understand the mechanisms involved, evolve new concepts and increase the body of knowledge in general.

Research recently has been conducted by about forty scientists at Fort Detrick, Maryland, utilizing recent dramatic strides in genetics that enables the breeding of a variety of resistance factors into particular bacterial or viral agents so that specific mutants could be developed that no longer would be sensitive to penicillin, streptomycin and other antibiotics. Speaking quite precisely of the contribution of geneticists to the development of biological weaponry, General Stubbs stated:

The in-house effort, particularly in microbial genetics, is supplemented by grants with universities, frequent consultations and correspondence with other experts in the science and attendance of research personnel at scientific meetings.

Although the biological laboratories conduct a vigorous and dynamic program in many areas of basic and applied genetics, it is certain that the effort, of necessity, will expand in the near future. It is not unlikely that the major contribution to biological weaponry will result from research and a better understanding of the science of genetics.

Because of the highly classified status of the research being done in this area, very little is known about the precise nature of developments of new strains other than that which is inferred from general information shared by the larger scientific community. According to this general knowledge, genetic research for the development of biological

68. U.N., Chemical and Bacteriological Weapons, supra note 13, at 73-74.
69. See note 65 supra.
70. S. Hersh, supra note 30, at 75.
71. S. Hersh, supra note 30, at 76.
72. Quoted in S. Hersh, supra note 30, at 76-77.
weaponry seems to be limited at present to the development of viral, rickettsial and bacterial strains, because these have the greater possibility of being used as weapons. Very few species of fungi appear to have any potential in biological warfare; as a matter of fact only one incapacitating species, coccidioidomycosis, seems to have any possibility at all of being so used. Protozoa appear to have very little potential use in this context, despite their role in such diseases as malaria, simply because of their very complicated life cycles. Parasitic worms cause illness and disability only after long exposure and repeated infection and would be extremely difficult to produce in quantity, to store, to transport or to disseminate in a weapon, and so are not considered in this context. It is further known that bacteria are more susceptible to genetic change, making them better adaptable for use as weaponry than rickettsiae, fungi, protozoan and parasitic worms. But precise information concerning the latest genetic developments using bacteria in this context is simply out of the reach of those who are not classified to traffic in this information.

When considering the possibility of biological warfare, however, consideration should not be limited to those agents which affect only man, for it is conceivable that biological germ strains could be developed by geneticists which could drastically affect the animal and plant population which sustains man. Although most of the genetic research in the development of biological weaponry appears to be aimed at man directly, it is well within the realm of possibility that epizootics such as foot-and-mouth disease and anthrax, and plant diseases such as rice blast and potato blight could and are also being developed. Any realistic legal considerations should take into account not only the known developments but also the possible developments in the use of genetics for the creation and production of biological weaponry.

III

LEGAL CONSIDERATIONS FOR REGULATING CHEMICAL AND BIOLOGICAL WARFARE

A. Existing Law on Chemical and Biological Warfare

The principal operating restraint in chemical and biological warfare at the multi-national treaty level is the Geneva Gas Protocol of 1925. Three international agreements preceded that agreement. In the Hague Gas Declaration—also known as the Hague Conferences of 1899 and 1907—the signers agreed not to use gas projectiles which

73. D'Amato et al., supra note 31, at 1091.
disseminated gases. In the Treaty of Versailles of 1919, the defeated powers were prohibited from manufacturing chemical and biological weapons. Condemnations of gas warfare by the League of Nations in 1921 never became legally effective. Several other conferences later treated chemical-biological warfare (CBW) problems indirectly and ineffectually. These latter meetings included the 1922 Washington Disarmament Conference, the 1923 Hague Air Warfare Rules, the Conference of Central American States in 1923, and the Fifth International Conference of American States in 1923.74

Advocates of the Geneva Gas Protocol noted that gas warfare had been condemned by the civilized world and that it was also prohibited by treaties to which most powers were parties. The Protocol prohibited the use of both poisonous gases and bacteriological methods of warfare, a prohibition which was to be universally accepted as part of international law, binding alike the conscience and the practice of nations. Although the United States delegates, along with the delegates of thirty-seven other countries, signed the Protocol, the United States Senate refused to ratify the treaty.75 The Protocol came into force for the signatory nations on February 8, 1928.

The United States has never ratified the Protocol, and therefore the United States is not a formal party to it. It was withdrawn from further consideration during President Truman's administration. In practice, however, the United States has been an informal party to the Protocol, or at least to its own interpretation of that law. This interpretation, as applied to the present conflict in Vietnam was expressed by Ambassador Nabrit, who stated that the Geneva Protocol

does not apply to all cases. It would be unreasonable to contend that any rule of international law prohibits the use in combat against an enemy, for humanitarian purposes, of agents that Governments around the world commonly use to control riots by their own people. Similarly, the Protocol does not apply to herbicides, which involve the same chemicals and have the same effects as those used domestically in the United States, the Soviet Union and many other countries to control weeds and other unwanted vegetation.76


Whether or not the United States is legally bound by the Protocol is a matter under extensive discussion by international law experts.\textsuperscript{77} This debate is perhaps beside the point, because those nations who have signed or adhered to the treaty with recorded reservations have changed the textual meaning from "never to use CB weapons" to "never to use CB weapons first."\textsuperscript{78}

The United States policy in regard to the use of such weaponry has been expressed on a number of occasions. President Roosevelt expressed this policy first in 1943 when he stated that the

\[ \text{use of such weapons has been outlawed by the general opinion of civilized mankind. This country has not used them, and I hope that we never will be compelled to use them. I state categorically that we shall under no circumstances resort to the use of such weapons unless they are first used by our enemies.}\textsuperscript{79}

On September 3, 1959 Representative Robert Kastenmeier introduced a resolution calling for the reaffirmation of "the long-standing policy of the United States that in the event of war the United States shall under no circumstances resort to the use of biological weapons or the use of poisonous or (noxious) gases unless they are first used by our enemies."\textsuperscript{80} The Departments of Defense and State opposed this resolution,\textsuperscript{81} and no action was taken.

A number of congressmen have frequently questioned the Department of Defense concerning the creation and stockpiling of chemical and biological weaponry. In 1967, while testifying before the Subcommittee on Disarmament of the Committee on Foreign Relations, the Deputy Secretary of Defense stated that "[i]t is clearly our policy not to initiate the use of lethal chemicals or lethal biologicals."\textsuperscript{82} However, after careful interpretation of the term "lethal," it was ascertained that the term presumably restricts this policy to "lethal to human beings" and to them only when "lethal by intent." Thus the interpretation of the Protocol on the part of the United States appears to be governed by tactical "necessity" of the use of tear gases and defoliants by the United States in Vietnam since about 1962.

President Nixon, on November 25, 1969, articulated a new United States policy on chemical and biological weaponry, stating:

\begin{itemize}
\item \textsuperscript{77} See L. OPPENHEIM, INTERNATIONAL LAW 348 (1952).
\item \textsuperscript{78} Id.; see text at appendix C, infra.
\item \textsuperscript{79} HERSH, supra note 30, at 22, 315.
\item \textsuperscript{80} Id. at 26-27, 316; Legislative Reference Service, Chemical and Biological Warfare 20 (Jan. 2, 1970).
\item \textsuperscript{81} S. HERSH, supra note 30, at 28-29, 316; 106 CONG. REC. 18,186-87 (daily ed. Jan. 19, 1960).
\item \textsuperscript{82} S. HERSH, supra note 30, at 25, 316.
\end{itemize}
As to our chemical warfare program, the United States:
—Reaffirms its oft-repeated renunciation of the first use of lethal chemical weapons.
—Extends this renunciation to the first use of incapacitating chemicals.

Biological weapons have massive, unpredictable and potentially uncontrollable consequences. They may produce global epidemics and impair the health of future generations. I therefore decided that:
—The United States shall renounce the use of lethal biological agents and weapons, and all other methods of biological warfare.
—The United States will confine its biological research to defensive measures such as immunization and safety measures.
—The Department of Defense has been asked to make recommendations as to the disposal of existing stocks of bacteriological weapons.83

As forthright as this statement seems on its surface, in its instantiation major problems of interpretation arise which have the effect of vitiating its apparent intent. The first obstacle lies in reconciling this statement with the use by the United States of tear gas and anti-plant agents in Vietnam. This sensitive problem has already been raised internationally and within the United States. The essence of the problem is whether tear gases and anti-plant agents are covered by the Geneva Protocol. Although the consensus of opinion among international groups and a majority of nations other than the United States is that these agents do fall within the general purview of the Geneva Protocol,84 the United States position has remained as it was set forth by Ambassador Nabrit before a plenary session of the United Nations General Assembly on December 5, 1966.85

The statement additionally raises the problem of bacterial toxins being defined as chemical or biological agents. Under definitions set forth by the Defense Department, bacterial compounds that are products of biological production techniques are considered to be chemical warfare agents, and thus are not included within the scope of the President's announced ban on biological warfare.86

84. S. Hersh, supra note 30, at 20-21, 25, 144, 146; see also D'Amato et al., supra note 31, at 1092-93.
85. See note 76 and accompanying text supra.
86. S. Hersh, supra note 30, at 22; see also, New York Times, Dec. 16, 1969, at 1, col. 6.
Further, the meaning of the term "offensive measures" remains debatable. Military strategists have forcefully argued that the development of an adequate defense requires detailed knowledge of offensive possibilities; therefore, a strong offensive program is required, if for no other reason than to verify that the defensive options have been thoroughly evaluated. In essence this means that genetic research should continue in the creation of inoculant-resistant strains of viruses and bacteria under the guise of defense, because it is alleged that through the development of these strains a better defense mechanism can be devised.

Although the United States has given informal assent to the Geneva Protocol, the interpretation rendered to the United Nations by Ambassador Nabrit enables the United States to use incapacitating chemicals and lethal defoliants without any prior use by the enemy. Although President Nixon has issued a series of announcements and plans directed at the prohibition of biological weapons use and research, the definitions rendered and the actual policies practiced by the Defense Department make any serious control of biological weapons research virtually impossible. The Geneva Protocol and the Presidential directives are therefore inadequate legal precautions against the creation and use of chemical and biological weaponry. Not only are these legal regulations inadequate regarding the manufacturing of these weapons, but under their present readings by those with the discretion to oversee their fulfillment, these legal regulations leave untouched the problems of genetic research in conjunction with the invention and creation of new weaponry and with the drastic potential effects of chemical weaponry upon human, animal and plant genetics.

These unresolved issues have been raised by concerned parties often in recent years. While addressed specifically to gas stockpiling near Denver, Colorado, the comments of some university professors there appropriately depict the overall dangers of recent chemical and biological weapons research:

We believe that technology best serves the cause of man when the consequences of the technical advance are examined as far as possible not only before the undertaking, but continually. Only in this way can we hope to escape the exorbitant cost of correcting massive problems after they have gotten out of hand.

87. 5 WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS 1660 (1969); See also D'Amato, et al., supra note 31, at 1092 n.228.
88. See note 76 and accompanying text supra.
B. Problems in Legal Regulation of Chemical and Biological Warfare

1. The general problem of balancing

In view of the rather scanty information available concerning the genetic effects of any kind of war, whether conventional, nuclear, chemical or biological, it is difficult to postulate many specific legal recommendations. Nevertheless, this very uncertainty may provide the most compelling argument of all for making some legal observations. Precisely because so little is presently known about the actual genetic effects of nuclear, chemical and biological warfare, there should be a natural hesitancy to engage in such ventures having the potentiality of severely crippling or even exterminating life on this planet. Since law is concerned about the regulation, education and engineering of human society, and since the available genetic information is at best uncertain, this uncertainty should be reflected in the law by prudent prohibition of the use of weapons carrying such obvious but unknown potential for harm.

Laws should be based solely upon present political, scientific, economic, sociological, historical, psychological and ethical knowledge. If any of that information is uncertain—and surely at any given point some aspect of it must be uncertain—then lawmakers must respond with a crude decision to curtail or permit the action in question in view of these uncertainties. This lawmaking pattern involves the age-old "balancing process"—balancing the degree of uncertainty with the seriousness of the potential danger, balancing technical knowledge with community consensus.

The major argument advanced to support the continuing creation and production of chemical and biological weaponry is that used constantly by military spokesmen in successfully obtaining appropriations for other enterprises: the expense and risk is necessary for national defense. This argument provides that in order to maintain national security, the citizens must be certain that there is a balance of power with regard to modern weaponry. Otherwise a nation might be so threatened that it would have to relinquish its prerogatives to nations that might have such weaponry. It is further argued along this line that the constant threat of retaliation is the only factor which serves to maintain a balance of power; thus, the power of retaliation must never be reduced. This argument is predicated on the premise that national identity is the highest of all values, to be preserved even at the risk of total annihilation. The fallacy of that logic is extant. At this point, this nation must balance the degree of its willingness to continue de-
development of chemical and biological weaponry for self-defense with consideration of the fact that such development jeopardizes the health and survival of man and other life forms, even in the phases of research and stockpiling.

Because this question involves a very delicate balancing process, a further legal question arises concerning which segments of society should bear this responsibility of judgment. The means and the extent of community inclusion in this balancing process must likewise be determined. Conceding that some legal controls must be effected in this context, the further question of the methods of achieving balanced controls must be addressed.

From a purely national legal perspective, withdrawn from international considerations, the issue becomes the degree of community participation in decisions regarding chemical and biological weaponry. Here the law must focus on balancing competence with concern. Presumably, almost everyone in the national community has a concern based upon public health or personal taxation. However, it is conceivable that neither every person in that community nor the community as a whole is competent to make these decisions. Yet, at the present the decision-making is far more narrowly based.

Under the present arrangement these decisions rest almost solely with the scientists and military experts who are working on these projects. This pattern should not typify the limits of interest-group insertion in this decision-making process. Numerous other factors, such as public health, the allocation of limited financial and human resources, and ethical factors must be taken into consideration. If law in the democratic and common-law traditions is to be created through consensus and an accumulative process, then those responsible for the law must become concerned with actions taken in the name and with the financial and human resources of this national community, by a few military strategists and genetic scientists who monopolize the informational

90. The exact sums spent on chemical and biological warfare have not been identified due in part to the secret nature of the work. It has been reported, however, that the Department of Defense has spent about 2.5 billion dollars on CBW programs since 1960. The annual level of funding has been placed at about 350 million dollars per year since 1964. This level of funding has been sharply restricted by recent actions of the Congress and by limitations on biological warfare imposed by the President's recent ban on BW. The exact amount that will be spent for FY 70 has not been established, however; it is obvious from the discussions held within the House and Senate thus far that significant reductions will occur, particularly in the areas of biological agent development, production and storage of biological agents and munitions, and the development of new chemical agents.

Legislative Reference Service, Chemical and Biological Warfare 7 (Jan. 2, 1970).
inputs and who control the research for these instruments of destruction.

To bring this balancing process under a broader aegis than that of a few single-minded scientists and military strategists would be consonant with this nation's legal origins and traditions. Such an approach would bring decision-making in this crucial area more effectively under the control of the legislative branch which is more capable of combining the necessary aspects of decision-making processes to reflect truly balanced and comprehensive decisions. "Science" should not be the only source of authority or sense in making decisions of this kind. In areas of domestic importance, such as the manufacture of and research on food, drugs and other products requiring scientific expertise, governmental regulation is normally and necessarily accepted. Thus, strategies for effective restriction of self-interested foreign-oriented research and manufacture may be suggested by these domestic regulatory experiences.

The present system of allocating so large a segment of the decision-making and balancing processes to the military-scientific sector seems blatantly narrow and restrictive. Legal surveillance of the military and scientific sectors of society by a larger spectrum of society regarding such vital matters as genetic research for the creation of biological weaponry is imperative. Greater legislative control would allow for the multivariate inputs that should be a part of this decision-making process, and at the same time would allow for adequate internal security.

2. A paradox of predictions

President Nixon has renounced the use of lethal and incapacitating chemical weapons.91 Meanwhile, the use of CS, CN, DM and cocodylic acid, as well as napalm and white phosphorus, alongside research and experimentation in chemical and biological weaponry have continued in and by the United States.92 In addition, research experimentation and production in chemical and biological weapons were continuing, as of 1968, in the Soviet Union, Great Britain, Canada, Communist China, Nationalist China, France, West Germany, Poland, Sweden, Spain, Egypt, Cuba, Israel and South Africa.93 The

92. See discussion of the meaning of the Nixon pronouncement at Part III, A, supra. See also authority cited at note 128, infra. The Presidential pronouncement had no actual effect on research concerning such weaponry. See text at Part III, A, supra.
93. S. HERSH, supra note 30, at 242.
presumed or alleged involvement of other nations has served as a stimulus or rationale for preparation and involvement\textsuperscript{94} of many nations and for escalation of efforts in others. The cycle of international development, familiar in terms of its resemblance to the cycle associated with nuclear weapons development, tends to move as follows:

Propaganda about $X-Y$ does "defensive" research and production—$X$ responds with "defensive" research and production—$Y$ escalates in commitment of energy and funds—propaganda about $Z$—continued.

This fragment includes only the portion of the cycle that is visible at large. It does not include occurrences behind barriers of military and international secrecy. Furthermore, the pattern traced above does not account for the "accidental" development of chemical and biological weapons. The operation of the cycle in combination with barriers of secrecy makes predictions regarding the actual extent of chemical and biological weapon-preparedness futile, and makes control and limitation within as well as among nations effectively unenforceable.

Given this lattice-work of allegations and propaganda, secrecy in experimentation and production, and perhaps even in deployment, and given the pressures toward misrepresentation, predictions about the future and sometimes present use of chemical and biological weapons must be made in a context of unknowns and unknowables. Predictions about the effects of chemical warfare in Vietnam are themselves hedged with considerable scientific ambiguity. However, resting though they do upon analogies and inferences, these predictions must be made.

Legal guidelines extrapolated from these ambiguities of prediction might provide the following insights: First, the availability of a given type of weapon, particularly where considerable investment of money and energy by government, business, and other institutions has been made in its production, provides a strong temptation toward its initial use.\textsuperscript{95} Stigmas upon use attach sporadically by popular or international opposition, but these tend to arise after initial use, if at all.

Secondly, causal hypothesis about even the most deleterious weapons tend to be corroborated only many years, dollars and lives after initial use. These hypotheses also tend not to be generally pursued, or such pursuits are not funded or supported by institutions, until the harms of initial use have gained some scientific attention. The scientific attention that develops the weaponry and therefore sets

\textsuperscript{94} See discussion of radiation-genetic patterns of causation, at Part II, B, \textit{supra}.

\textsuperscript{95} See S. Hersh, \textit{supra} note 30, at 237-38, 256-57.
up the pattern described in the first guideline presented here tends to precede this remedial focus. Thirdly, even where causal hypotheses are strengthened or are validated after initial use, scientific findings about actual and potential harms in no practical sense guarantee the proscription of continuing manufacture or use of the weapons in question.

This pattern of damage before remedy does not seem to be peculiar to the science and politics of weaponry. It has been summarized many times, and recently in a commentary by biologist Garrett Hardin:

When we think in terms of systems, we see that a fundamental misconception is embedded in the popular term “side-effects” . . . . This phrase means roughly “effects which I hadn't foreseen, or don't want to think about.” As concerns the basic mechanism, side-effects no more deserve the adjective “side” than does the “principal” effect. It is hard to think in terms of systems, and we eagerly warp our language to protect ourselves from the necessity of doing so.96

This comment about foreseeability and causation is relevant to possible roles of legal theory in relation to the science and politics of weapons use and development. A fuller discussion of that relevance follows.

3. The tension of scientific and legal standards of proof

The scientific standard of foreseeability which Garrett Hardin advocates, and which quantitative and objective methods are designed to meet, is not an extant standard in law. In general, the anticipation of “side-effects” by prediction and revision of legal premises has not been a primary purpose of developing theories of legal causation.

Legal proof and procedure is only pinned down to scientific realities and physical probabilities to the extent that considerations of fairness, deterrence and retribution require.97 Lawyer-anthropologist Vilhelm Aubert has described this relationship of legal to scientific evidence:


97. Consider in this context the famous case of Palsgraf v. Long Island R.R. Co., 248 N.Y. 339, 162 N.E. 99 (1928). There the court refused to find liability where defendant's conductor pushed a passenger into the coach, causing the passenger's package, containing fireworks, to fall and explode, which in turn caused a set of scales at the other end of the platform to fall on the plaintiff. If the package had actually contained a bomb, and if the conductor had known about it beforehand, there seems little doubt that Justice Cardozo would have linked up the lines of causation and found “criminal” liability. Indeed Justice Cardozo himself noted that in cases of willfully dangerous conduct, the actors would be acting at their peril. Id. at 344, 162 N.E. at 101. The authors are indebted to Professor Robert Cole of Boalt Hall for his enlightenment in this analysis.
Law is primarily not concerned with causal processes, nor with phenomena that have a dimension in time. "Causality" as a legal concept is something rather different from the causality, correlation, or invariance of the natural or social scientist. In the final analysis the concept of "causality" in law turns out to hinge upon a normative criterion. If an act shall be taken to have caused some damage, for which the actor is to answer in terms of criminal or civil liability, this depends upon the reasonableness of expecting the actor to foresee and forestall the damage.\(^8\)

The reasonableness of the actor's potential liability is not the sole means of determining the legal outcome. Sometimes the popularity or aesthetic appeal of potential liability is determinative. The public often expresses unwillingness to reconcile scientific fact and legal theory, especially where popular conceptions of cause are based on psycho-cultural needs to find fault or to issue blame. Thus public and legal conceptions of "actual" cause can be in conflict with scientific, "rational" reconstructions of cause. "Non-rational" criteria can be expected to play a very important role in determining causation where there is public controversy.\(^9\)

The regulation of chemical and biological weapons poses precisely such an instance of public controversy, where the "non-rational" and normative criteria to which Aubert has alluded can be expected to play a significant role. That is, to the extent that law is enforceable against the acts of nations in wartime at all, a tension necessarily arises between ethically drawing causal lines in order to maximize responsibility and scientifically drawing causal lines to identify origins, rather than fault.\(^10\)

There may be values, including the satisfaction of public frustration and the establishment of short-term deterrence, in holding the United States strictly or even criminally liable for all damages occurring in Indochina during the period of use of chemical weapons, including tear gas and defoliants. There may be competing values, such as the effective administration of remedies of reparation and the need for a precise calculation of monetary damages, in holding the United States liable only for harm caused by the use of chemical weapons, which causal hypotheses must be established by scientific proof in a quantum

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99. For example, it does not appear that state legislatures are currently composing criminal laws that punish possession of marijuana primarily on the basis that scientific experimentation has demonstrated dangers commensurate with long terms of imprisonment.
100. This proves particularly true where scientific causal lines are unclear. See, *e.g.*, discussion of radiation at Part II, B, *supra*. 
considered unnecessary if measured by the "non-rational" criteria of liability that persons supporting or opposing the war in Indochina might personally desire to impose.

The nature of legal order in war appears historically to have turned more upon the fairness and sanity of its enforcers than upon the rationality of the causal lines drawn within a given legal policy or rule sought to be applied. At its logical extreme, the existence of this pattern of personality-centered law enforcement in wartime spurs the argument that to apply any law in any war is an anomalous process. On the other hand, that line of attack upon applications of law to warfare grossly understates the role of law in the prevention, limitation and control of the means of warfare, in both normative and descriptive senses, especially when "law" is used to connote unwritten custom along with articulated rule. Thus, it seems justifiable to pursue and wrestle with the formulation of legal regulations upon wartime activities, based upon the assumption that the enforceability of such regulations may be increased through understandings gained in, for example, cross-cultural study and research about law and warfare.

The Geneva Protocol of 1925, prohibiting the use of "asphyxiating, poisonous, or other gases, and ... all analogous liquids, materials, or devices,"\(^\text{101}\) has been interpreted to provide a basis for charging the United States with "war crimes" in relation to its use of each of the chemical weapons in Vietnam.\(^\text{102}\) The Protocol's arguably absolute prohibition of the use of all gases\(^\text{103}\) appears to avoid the problem of relationship between legal and scientific causal lines by omitting the issue of causation altogether. The Protocol has been interpreted to reflect a "revulsion against the kinds and uses of gases employed in the first world war;"\(^\text{104}\) in this respect, it includes gases which pose genetic and ecological threats or which do genetic and ecological harm, not because of such threats or harm, but because there are gases involved.

While the Geneva Protocol might well be interpreted to proscribe past, present and future United States chemical and biological warfare in Vietnam, and from these authors' data concerning the lethality of the chemicals involved, it clearly does so,\(^\text{105}\) the Protocol contains

\(^\text{101}\) Protocol Prohibiting the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, of June 17, 1925, 94 L.N.T.S. 65; 3 M. HUDSON, INTERNATIONAL LEGISLATION 1670 (1931). The Protocol is reprinted as Appendix C, infra.
\(^\text{102}\) D'Amato et al., supra note 31, at 1091-97.
\(^\text{103}\) D'Amato et al., supra note 31, at 1091-1097.
\(^\text{104}\) Id. at 1093 (emphasis in the original).
\(^\text{105}\) After thorough assessment of relevant principles of international law and available evidence regarding the Indochinese War, other authorities have decided likewise. See id. at 1093-97. See generally, B. WEISBERG, supra note 28.
some unreasonable limitations in view of data showing mediate- and long-term harms caused by such chemicals. For example, if an herbicide were used that posed no short-term risks to men or animals, although it established a cycle of erosion to soil infertility to starvation to heightened sensitivity to irradiation, it arguably would not be a violation of the Protocol to use such an herbicide.

Further limits inhere in the general reliance on the Protocol to translate twentieth century experiences with irradiation, pesticides and mustard gas into standards of conduct and to educate potential users of such weapons about these experiences. President Nixon and former President Johnson have interpreted United States chemical warfare in Southeast Asia as not forbidden by the Protocol and by the international understanding that it symbolizes. Moreover, the Protocol's limitation of "asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices," taken in the context of war crimes, ignores the devastating historical experience of persons with respect to "emergency" rationales. It disregards the need for a preventive rather than a post hoc schemata in the treatment of technological escalations in warfare.

IV

BARRIERS TO LEGAL REGULATION OF SCIENTIFIC RESEARCH

The government of the United States, in the company of many others, has often succumbed in wartime to the temptations of authorizing the use of untested and often genetically untestable weapons, even where evidence then available strongly suggests side effects. Examples include President Truman's decision to use atomic bombs on Hiroshima and Nagasaki and President Johnson's toleration of the Pentagon-centered decision to defoliate. Although not involving a particular weapon, the decision to send U.S. troops into Cambodia in 1970 is comparable to these others in its arguable illegality and its emergency and war-shortening rationales.

If it is correct that these rationales "wipe out all the laws of war-

106. Reynolds, supra note 4, at 300.
108. S. Hersh, supra note 30, at 123-59; see text at part III, A, supra.
110. D'Amato, et al., supra note 31, at 1093-95; S. Hersh, supra note 30, at 75-78.
111. S. Hersh, supra note 30, at 132-42.
fare," it is equally correct that as a matter of custom these rationales have become the laws of warfare. The logic which provides these rationales, or the pressure which stimulates them, also links them with the notion of relatively greater "humaneness" of the acts in question, since "doing the most brutal and hitherto illegal acts would bring the enemy to its knees and hence be humane." In the teeth of evidence and analogies suggesting the multiple and intense harms to populations and ecosystems posed by some of the weapons in question, this rationale evaporates into nonsense. When it is offered by those who have reason to know of these potentialities, the rationale becomes a misrepresentation or a lie.

Absurd or untrue, the "humaneness" rationale recurs in the writings and speeches of the apologists for chemical and biological weaponry. For example, Lt. Col. Augustin Prentiss, Ph.D., of the United States Army Chemical Warfare Service ended his voluminous 1937 treatise on chemical warfare designed to set right "the happy hunting ground for sensational newspaper and magazine writers whose imaginations have furnished lurid pictures of whole populations being wiped out at a single blow with poison gas dropped from airplanes," with the following statement of the humaneness rationale:

"Who that had to die from a blow would not rather place his head under Nasmyth's hammer, than submit it to a drummer boy armed with a ferrule?"

If the statesmen who control the destinies of nations could but achieve this enlightened viewpoint, the future of mankind would be far more secure.

Alongside the "humaneness" and "emergency" rationales developed in the military-political community, some scientists have offered an equally illogical and deceptive rationale to justify experimentation with the production of chemical and biological weaponry. This could be termed the "great discoveries" rationale, the main component of which is that funding, support and freedom for such weapons research have enabled scientists to discover causes of cancer and cures

112. D'Amato et al., supra note 31, at 1093 n.232.
113. Id.
114. A. PRENTISS, CHEMICALS IN WAR 697-700 (1937); S. HERSH, supra note 30, at 133. See also Id. at 147, 148, 151.
115. A. PRENTISS, supra note 114, at viii.
116. Id. at 700. For a poet's response to this poetic passage (quoted by A.M. PRENTISS FROM GREEK FIRE) see Phillip Levine's The Horse, in ANTHOLOGY OF MODERN POETS 1940-1960 (M. Strand ed. 1969). The Horse describes the realities of Hiroshima, through the eyes of the horse who lost his hair and flesh and of those people who watched him die.
for leukemia.\textsuperscript{117} Were it not for governmental nurture of weaponry programs, the rationale goes, these discoveries would be delayed if not missed entirely.

A specific example of this “great discoveries” rationale is that offered for the continuation of genetic research for the discovery of more virulent germ cells having anti-inoculant resistance transfer factors. The supportive argument is that such research has positive value: through it, by isolating certain harmful bacterial and viral strains, more refined innoculants and antibiotics can be developed. In balancing the restrictions on this type of research from a legal point of view, one must carefully analyze the exact nature of the genetic research taking place in this area lest the positive and beneficial aspects be subtly negated.

In resolving this delicate problem one must distinguish between two phases of the genetic contribution of the development of biological weaponry: first, research in the discovery of new germ mutants, and second, production of those mutants for use in weaponry. Whereas certain positive values inhere in the former, it is difficult to justify research that attempts to make these germ mutants into better weapons. Certain positive values can be found in the discovery of new germ mutants such as the development of new innoculants and antibiotics for potential variant strains of viruses, rickettsiae or bacteria; but the purposeful and intentional production of those deleterious strains in great numbers poses such an obvious threat to international and even national health, that it would seem only prudent to bring this production under some legal control. In balancing the positive with the negative aspects it is difficult to argue for research which contributes and has contributed to the mass production of virulent germ strains, in view of the potential harm that could result from accident, testing, incautious storage, or actual use.

Even in the research phase which develops new germ strains, two distinct features must be recognized for legal purposes: first, the purposeful creation of deleterious germ mutants, having the qualities of high virulence and antibiotic-resistance, through calculated genetic manipulation or chemical manipulation of nucleic acids, and second, the discovery of new viral, rickettsial and bacterial mutants. Certainly the first type of research should not only be refused funds, but must be

\textsuperscript{117} T. Watkins, Chemical Warfare, Pyrotechnics and the Fireworks Industry 28, 48 (1968). Dr. Watkins failed to note that while the “great discoveries” regarding mustard gas linkages with cancer were being explored, workers were making mustard gas which was never used in World War II and were contracting lung cancer in the process. See discussion at Part II, A. supra.
outlawed. It is difficult to view the first type of genetic research as making any positive contribution to man, since here genetic knowledge is actually used to create new strains of germs which have antibiotic resistance transfer factors. In this case, the motivation for research can only be destructive, and its result is potentially dangerous to all human health. Its aim cannot be to contribute to genetic knowledge, but to engineer virulent germ strains which may not otherwise be generated through natural processes.

Legal decision-makers must keep in mind that they face multivariate interests here and in this case they have an epistemological decision to make. The law must reflect the subtle sensitivity of the distinction between receptive knowledge and manipulative knowledge. The former is characterized by a methodology which seeks to gather new data and information. The latter is characterized by an attempt to control through existing knowledge. These two types of knowledge are not mutually exclusive, because it frequently happens that through the intelligent manipulation of existing knowledge, new data is acquired; or, through calculated control, natural forces can be directed to serve man in a positive and constructive manner. In the particular type of genetic research under question, in which pathogenic viruses, rickettsiae and bacteria that would not otherwise exist, are created through the calculated manipulation of genetics, there appears to be no new genetic knowledge gained. Furthermore the calculated control of genetics in this way is performed for purposes which are solely deleterious to and destructive of man. Contrast with this the discovery of genetic bases of diseases, which surely may be manipulated in negative directions but which are aimed at the improvement of health care. Because the purposes, aims and results of this research are so negative in all aspects, and consist in engineering for man's detriment rather than for his benefit, it would seem rational that such research be forbidden by both national and international law.

It is fair to recognize that hard-and-fast distinctions between peaceful and warlike great discoveries may be technologically and scientifically unsound. Yet it is a form of intellectual trickery to argue from the difficulty of drawing a line between peaceful and warlike science that the diversion of money, energy, and talent into the research and production of chemical, biological or genetic-ecological weapons should carry a higher priority than direct studies of cancer and leukemia. Although some scientists and industrialists have ardently dissented from these sophistic justifications, many others have accepted them.119

118. V. McKusick, supra note 5, at 5-6.
119. See, e.g., authority cited at note 117, supra. Dow Chemical Company's
CONCLUSION: CROSS-INSTITUTIONAL ISSUES

A full discussion of the possible roles of law in relation to the genetics of warfare would have to consider a variety of orientations: recommendations about legal and scientific ethics, proposals to rearrange power structures in order to minimize the pressures toward inhumane act in wartime, international agreements proscribing certain uses and tests of weapons, and discouragement of growing complexes of power among institutions and individuals. But the authors have determined that such discussion as worthwhile or mooted as it might be, misses the point of the scientific, legal and moral problems described in this commentary.

One of the most profound issues raised here, the authors believe, is that set which might be termed “cross-institutional.” The fact that war is itself “cross-institutional” in its origins, targets, and effects supports the use of a model of comparable complexity. The issues raised here respecting chemical and biological warfare actually cross all methods and sources of war. Thus the authors seek in conclusion to suggest a direction by which that cross-institutional model of war may be adapted to the task of avoiding single-variable treatment, whether legal or otherwise, of the issues discussed here.

The psychological and anthropological uniqueness of twentieth century warfare combined with the interrelated genetic and ecological effects of such warfare, suggest a means of identifying and perhaps dealing with these issues. The distance between warring parties and the consequent anonymity of men and cultures, accompanied by the short-term invisibility of the genetic and ecological effects of modern warfare, cast doubt on the whole of modern warfare. If war were ever a form of symbolic communication among men or nations, if war were ever a mode of resolution or dissolution among conflicting cultures, religions, or “races”—and if any of these purposes were ever served in fact by past wars—it is highly questionable that these explanations could support the present involvement. These explanations do not make sense in the context of the potentials for and the reality, par-

attitude toward these rationales exemplifies the acceptance of them among some industrialists. See S. Hersh, supra note 30, at 161-226, especially at 224, where a Dow executive supposes that “if Dow didn't make [napalm], the government would have to turn to some other supplier.” Dow's rationale is significant here because it carries the premise that, since some scientists and industrialists will be milking the negatives from their knowledge somewhere, why not Dow? It should be noted that the economic consequences of this attitude for Dow have not been as uniformly positive as the napalm market would tend to suggest. Medical Comm. for Human Rights v. S.E.C., 432 F.2d 659 (1970).

120. See text at Part I, supra.
particularly at present in Indochina, of anonymous, impersonal attacks having initially invisible and eventually indescribable effects.

In summary, these authors submit that war and peace must fundamentally and originally be matters of concern to individuals. Invisible warfare facilitated by modern technology occurs as individuals remain numb and distant. Law, science, and other related expressions and vehicles of concern shall be fundamentally and originally altered toward cooperative construction only when individuals think and feel this concern about the invisibles of modern warfare and begin to act upon it.

Invisible warfare has been described this way:

If we go beyond the abstract image and force ourselves to look at the object itself, moving and wriggling, and making noises, or we see the event itself—an automobile accident or someone in the throes of being beaten severely (these are the more spectacular examples)—we will discover that the problem lies not in being under-educated. I recommend that we try over a period of time looking directly into the faces of autistic children or the types of babies that can be found lying on beds in our slums. . . . After we have looked at enough of such objects we can have unpredictable mental reactions, certain types of dreams, for instance, which are revealing. One may be looking into a kaleidoscope, where each piece of color can become a child’s face or a characteristic sound from these children—red being a cry, blue for another failure, yellow for the long unbroken period of silence. These are the conversations of the children who are being subjected to the “process.” I know it is possible for such dreams to take place because I have had them.121

Such dreams cannot be legally, politically, or scientifically compelled. If this is so, the end of all such nightmares on earth must begin with the opening of our sensitivity and the channeling of our creativity to the wounds of all these wars.

The findings synthesized earlier, regarding the genetic and ecological harms and risks of chemical weaponry, leave a painful impression. There is no help nor relevance in those findings without personal and collective dedication to the pursuit of the wider questions which they raise. Feodor Dostoevsky observed that the most exquisite and despicable characteristic of man is that he adapts.122 If those who have perceived the horror and misery of war, from whatever

122. This theme courses throughout Dostoevsky’s work. See, e.g., F. DOSTOEVSKY, MEMOIRS FROM THE HOUSE OF THE DEAD (1861).
vantage point and proximity, adapt to those perceptions, then the insight and energy of those persons may be lost; yet if those persons do not adapt to their perceptions, their functional cognition is jeopardized. In the midst of this paradox, the implications of chemical and biological warfare remain unresolved.

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Mary Cynthia Dunlap**

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### Appendix A: Chemical Weaponry Employed by United States Forces in Indochina (1962-1970)

#### Table I: Some Known or Predictable Short-Term Effects

<table>
<thead>
<tr>
<th>To:</th>
<th>CN, CS</th>
<th>DM (Adamsite)</th>
<th>2, 4-D/2, 4, 5-T</th>
<th>Cacodylic Acid</th>
<th>Napalm</th>
<th>White Phosphorous</th>
</tr>
</thead>
<tbody>
<tr>
<td>man</td>
<td>lacrimation respiratory irritation nausea (CS) skin irritation death</td>
<td>head &amp; chest pain nausea vomiting eye &amp; nose irritation blindness miscarriages death</td>
<td>skin &amp; eye irritation blindness miscarriages death (due to ingestion of arsenical components)</td>
<td>same as for 2,4-D/2,4,5-T combinations</td>
<td>death (by burning and/or asphyxiation) injury by burns</td>
<td>death (by burning and/or asphyxiation) injury by burns</td>
</tr>
<tr>
<td>other animals</td>
<td>same as to man (some animals are extra-sensitive to arsenical toxicity)</td>
<td>same as to man</td>
<td>death (animals cannot distinguish sprayed from unsprayed grazing areas)</td>
<td>death (as well as nonlethal arsenical effects, as with 2,4-D/2,4,5-T combinations)</td>
<td>same as to man (at perhaps higher rates due to incapacity for escape)</td>
<td>same as with napalm (WP is an effective &quot;flesh—incendiary&quot;)</td>
</tr>
<tr>
<td>plants</td>
<td>scorching death</td>
<td>death tainting of growing crops (retention of arsenic)</td>
<td>death (plants either &quot;burn up&quot; or &quot;grow themselves&quot; to death)</td>
<td>death (cachodilic acid acts more quickly, in general, than 2,4-D/2,4,5-T)</td>
<td>scorching death destruction (e.g. burning forests)</td>
<td>scorching destruction (poisoning when in contact with solid WP (e.g. crops))</td>
</tr>
<tr>
<td>food supplies</td>
<td>tainting poisoning</td>
<td>death tainting of growing crops (retention of arsenic) flavor changes (some foods)</td>
<td>destruction tainting (retention of arsenic and cyanide compounds) production and retention of dioxin</td>
<td>destruction tainting (retention of arsenic)</td>
<td>persistence of CO in foods of porous consistency possible</td>
<td>flavor changes (with WP smoke) toxicity (with WP solid)</td>
</tr>
<tr>
<td>water</td>
<td>no hydrolyzation in H$_2$O (persistence questionable)</td>
<td>no hydrolyzation in H$_2$O (persistence of arsenic possible)</td>
<td>persistence of arsenic, cyanide compounds and dioxin likely</td>
<td>persistence of arsenic likely</td>
<td>persistence of elements unlikely (unless poured into H$_2$O before ignition)</td>
<td>toxicity (with WP solid)</td>
</tr>
<tr>
<td>soil</td>
<td>retention of arsenic possible (as with herbicides and pesticides)</td>
<td>retention of poisonous elements and compounds very likely</td>
<td>same as for 2,4-D/2,4,5-T combinations</td>
<td>CO and gasoline effects upon soil unknown</td>
<td>scorching of topsoil possible</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>air</td>
<td>same as to soil (air=the medium of deployment)</td>
<td>retention and accumulation of toxins likely</td>
<td>same as for 2,4-D/2,4,5-T combinations</td>
<td>persistence and accumulation of CO (carbon monoxide)</td>
<td>persistence of toxic by-products possible</td>
<td></td>
</tr>
</tbody>
</table>

### Appendix A: Chemical Weaponry Employed by United States Forces in Indochina (1962-1970)

#### Table II: Some Known or Predictable Mediate-Term Effects

<table>
<thead>
<tr>
<th>To:</th>
<th>CN, CS</th>
<th>DM (Adamsite)</th>
<th>2, 4-D/2, 4, 5-T</th>
<th>Cacodylic Acid</th>
<th>Napalm</th>
<th>White Phosphorous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>man</strong></td>
<td></td>
<td>death (by repeated exposure or by sensitization due to illness or age) respiratory damage</td>
<td>death (by systemic arsenical poisoning, through ingestion of contaminated food or water)</td>
<td>same as short-term effects (Table I) stomach upsets</td>
<td>same as short-term effects (Table I) stomach upsets</td>
<td>death burns difficult to heal (disproportionate suffering of children) inhalation of accumulated CO</td>
</tr>
<tr>
<td><strong>other animals</strong></td>
<td></td>
<td>death respiratory damage</td>
<td>death (higher risk than man—animals cannot hide nor avoid ingesting arsenic)</td>
<td>same as short-term effects (Table I) (ecotoxication via food chains—see Table III)</td>
<td>same as short-term effects (Table I) (ecotoxication begins—see Table III)</td>
<td>same as to man (perhaps greater risks of death and injury)</td>
</tr>
<tr>
<td><strong>plants</strong></td>
<td>no effects known</td>
<td>possible temporary prevention of regrowth possible continuing arsenical toxification</td>
<td>temporary prevention of regrowth (ecotoxication—see Table III)</td>
<td>(temporary) soil sterility prevents regrowths (ecotoxication—see Table III)</td>
<td>possible retardation of growth and reproduction (as with areas alongside U.S. highways)</td>
<td>same as or similar to napalm (poisoning when in contact with WP solid)</td>
</tr>
<tr>
<td><strong>food supplies</strong></td>
<td>no mediate-term effects known</td>
<td>retention of arsenic, cyanide, dioxin</td>
<td>retention of arsenic</td>
<td>retention of arsenic likely</td>
<td>persistence of CO in foods questionable</td>
<td>persistence of smoke too low (arguably) to affect foods after a few hours (toxicity if contact with WP solid)</td>
</tr>
<tr>
<td><strong>water</strong></td>
<td>same as for food supplies</td>
<td>retention of arsenic possible</td>
<td>retention of toxins likely (ecotoxication—see Table III)</td>
<td>retention of arsenic likely</td>
<td>persistence unlikely unless poured into water before ignition</td>
<td>persisting toxicity and contamination (with WP solid)</td>
</tr>
<tr>
<td>soil</td>
<td>same as for food supplies</td>
<td>retention of arsenic possible (as with herbicides and pesticides)</td>
<td>sterility (of variable duration) retention of toxins</td>
<td>same as for 2,4-D/2,4,5-T combinations (sometimes greater persistence)</td>
<td>CO and gasoline effects upon soil unknown (possible drying out)</td>
<td>soil damage possible (especially in heavy fire areas)</td>
</tr>
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</tr>
<tr>
<td>air</td>
<td>persistence unlikely; accumulation unlikely except in closed areas (e.g. caves)</td>
<td>accumulation of arsenical vapors possible in heavily sprayed areas (especially jungles)</td>
<td>retention of toxins likely (ecotoxicification—see Table III)</td>
<td>same as for 2,4-D/2,4,5-T combinations</td>
<td>persistence of CO (and accumulation in heavy-fire areas)</td>
<td>persistence of smoke (arguably) too low to cause “air pollution”</td>
</tr>
</tbody>
</table>

124. Sources of data for appendix A, Table II: CS, CN—S. Hersh, supra note 30, at x; D'Amato et al., supra note 31, at 1094; U.N., CBW, Table of lethal indices, supra note 13, at 71; DM—S. Hersh, supra, at x, 157; The Subversive Science, supra note 4, at 240; D'Amato et al., supra; M. Jacobs, supra note 29, at 57; Defoliants—see T. Whiteside, supra note 123, at 36-39; B. Weisberg, supra note 28, at 49-98, regarding the production and teratogenic results of “dioxin”; Napalm, White Phosphorus—see authorities at note 123 supra.
### Table III: Some Known or Predictable Long-Term Effects

<table>
<thead>
<tr>
<th>To:</th>
<th>CN, CS</th>
<th>DM (Adamsite)</th>
<th>2, 4-D/2, 4, 5-T</th>
<th>Caeodylic Acid</th>
<th>Napalm</th>
<th>White Phosphorous</th>
</tr>
</thead>
<tbody>
<tr>
<td>man</td>
<td>mutagenesis (CS)</td>
<td>death (by poisoning)</td>
<td>teratogenic effects likely</td>
<td>same as 2,4-D/2,4,5-T; by translation of mice studies, cancer and death analogous to DM</td>
<td>death; deformities, carcinogenic risks (comparable to &quot;air pollution&quot; in U.S.) in heavy-fire areas (CO accumulation)</td>
<td>death; deformities</td>
</tr>
<tr>
<td></td>
<td>death (continued exposure, carcinogenic possibility of alkylating agent) (CS)</td>
<td>carcinogenic effect; analogy to alkylating agents</td>
<td>starvation, therefore; extrasensitivity to radiations analogous to DM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other animals</td>
<td>gross chromosomal abnormalities produced in <em>Drosophila</em> and some other animals</td>
<td>same or greater risks as for man; ecotoxification (arsenic in food chains, as with pesticides)</td>
<td>same as for man (perhaps greater risks)</td>
<td>same as for man</td>
<td>same as for man; stimulation of changes in habitat patterns</td>
<td>same as for man (perhaps greater risks of death and injury)</td>
</tr>
<tr>
<td>plants</td>
<td>no effects known</td>
<td>possible long-term alterations of growth patterns; ecotoxification (due to arsenic)</td>
<td>changes in growth patterns; possible long-term sterility; ecotoxification by arsenic, cyanide, dioxin</td>
<td>possible long-term soil sterility; ecotoxification by cyanide</td>
<td>possible non-reproduction in CO-dense areas</td>
<td>same as with napalm— ecotoxification possible where long in contact with WP solid</td>
</tr>
<tr>
<td>food supplies</td>
<td>no long-term effects known (persistence in food unlikely)</td>
<td>retention of arsenic</td>
<td>retention of toxins</td>
<td>retention of arsenic</td>
<td>persistence of CO for months in food unlikely</td>
<td>same as mediate-term effects</td>
</tr>
<tr>
<td>water</td>
<td>same as to food supplies (and therefore ingestion by water-life) possible</td>
<td>retention of arsenic</td>
<td>ecotoxification by food chains (shellfish life cycles upset by defoliation and death of mangrove trees)</td>
<td>ecotoxification by food chains (effects on shellfish as with 2,4-D/2,4,5-T)</td>
<td>ecotoxification only where unignited napalm accumulates in water supplies</td>
<td>same as mediate-term effects; possible aquatic ecotoxification (with WP solid)</td>
</tr>
<tr>
<td>soil</td>
<td>same as to food supplies</td>
<td>source of ecotoxicification (by passage of arsenic into food chains, as with herbicides, pesticides)</td>
<td>source of ecotoxicification; deserts created in formerly forested areas</td>
<td>same as with 2,4-D/2,4,5-T combinations</td>
<td>soil sterility possible in heavy-fire areas; erosion due to fires</td>
<td>soil damage and erosion (in heavy-fire areas particularly)</td>
</tr>
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</tr>
<tr>
<td>air</td>
<td>persistence, even in closed areas, unlikely</td>
<td>retention of arsenical vapors in heavily sprayed areas possible</td>
<td>ecotoxicification; changes in locales of birds formerly in jungles (driven away by toxins)</td>
<td>same as with 2,4-D/2,4,5-T combinations</td>
<td>“air pollution” by accumulation of CO (especially in heavy-fire areas)</td>
<td>same as mediate-term effects</td>
</tr>
</tbody>
</table>

125. Sources of data for appendix A, Table III: CS, CN—see generally C. Purdom, Genetic and Allied Effects of Alkylating Agents, regarding the mustard gas-mutagenic effects analogy; DM—id.; see also M. Jacobs, supra note 29, at 36; Defoliants—see generally, T. Whiteside, supra note 123, at 13-14, 18, 36-39, and 61-68; The Subversive Science, supra note 4, at 235-56, 240, 300; S. Hersh, supra note 30, at 139; Napalm, White Phosphorus—The Subversive Science, supra, at 235-56; see also authority in note 123 supra.
BACTERIAL AGENTS:

Anthrax. An acute bacterial disease that is usually fatal if untreated when it attacks the lungs (pulmonary anthrax). Death can result in twenty-four hours. Found naturally in animals, which must be buried or burned to prevent contamination. Symptoms include high fever, hard breathing, and collapse. Also known as wool-sorters' disease.

Brucellosis. Bacterial disease usually found in cattle, goats and pigs. Marked by high fever and chills in humans. Also known as undulant fever. Fatal in up to five per cent of untreated cases. Symptoms can linger for months.

Plague. Acute, usually fatal, highly infectious bacterial disease of wild rodents found in two forms—bubonic and pneumonic. Symptoms of bubonic plague include small hemorrhages, and the black spots that led the disease to be commonly known as the "black death" during the massive epidemics of the past. Pneumonic plague is highly infectious because it is spread from man to man via coughing. Symptoms include fever, chills, rapid pulse and breathing, mental dullness, coated tongue, and red eyes.

Tularemia. A bacterial disease marked by high fever, chills, pains, and weakness. Acute period can last two to three weeks. Sometimes causes ulcers in mouth or eyes, which multiply. Untreated, its mortality rate is between five and eight per cent. Highly infectious, and usually found in animals, fowls, and ticks. Also known as rabbit fever.

VIRAL AGENTS:

Encephalomyelitis. Highly infectious viral disease that appears in many forms and gradations; it can be simply debilitating or fatal. Venezuelan equine encephalomyelitis kills less than one percent of its victims and lasts as few as three days; Eastern equine encephalomyelitis is fatal about five per cent of the time, if untreated, and can seriously cripple the central nervous system of survivors.

Psittacosis. Viral infection in birds that is transmissible to man, with symptoms of high fever, muscle ache, and disorientation. Disease can be mild, and last less than a week, or can cause death in upwards of forty per cent of those afflicted. Complete convalescence may take months.

126. See generally U.N., Chemical and Bacteriological Weapons, supra note 13.
Rift Valley Fever. Viral infection of sheep, cattle and other animals that can be transmitted to humans, usually to the male. Symptoms include nausea, chills, headaches, and pain, but the disease is mild; despite the severity of symptoms deaths are rare and acute discomfort lasts only a few days. Also believed to be more virulent among Asians.

RICKETTSIAL AGENTS:

Q-Fever. Acute, rarely fatal rickettsial disease usually found in ticks, but also found in cattle, sheep, goats, and some wild animals. The Q-fever organism can remain alive and infectious in dry areas for years. Rarely fatal but the resulting fever may last up to three months.

Rocky Mountain Spotted Fever. An acute rickettsial disease transmitted to man by the tick. One of the most severe of all infectious diseases. Can kill within three days. Fevers range up to 105 degrees F. Often found in northwestern United States, but susceptibility to the disease in general. Highly responsive to treatment.
APPENDIX C

GENEVA PROTOCOL, JUNE 17, 1925

THE UNDERSIGNED PLENIPOTENTIARIES, in the name of their respective Governments:

WHEREAS the use in war as asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilised world; and

WHEREAS the prohibition of such use has been declared in Treaties to which the majority of Powers of the world are Parties, and

TO THE END that this prohibition shall be universally accepted as part of International Law, binding alike the conscience and the practice of nations;

DECLARE:

That the High Contracting Parties, so far as they are not already Parties to Treaties prohibiting such use, accept this prohibition, agree to extend this prohibition to the use of bacteriological methods of warfare and agree to be bound as between themselves according to the terms of this declaration.

The High Contracting Parties will exert every effort to induce other States to accede to the present Protocol. Such accession will be notified to the Government of the French Republic, and by the latter to all signatory and acceding Powers, and will take effect on the date of the notification by the Government of the French Republic.

The present Protocol, of which the French and English texts are both authentic, shall be ratified as soon as possible. It shall bear today’s date.

The ratifications of the present Protocol shall be addressed to the Government of the French Republic, which will at once notify the deposit of such ratification to each of the signatory and acceding Powers.

The instruments of ratification of and accession to the present Protocol will remain deposited in the archives of the Government of the French Republic.

The present Protocol will come into force for each signatory Power as from the date of deposit of its ratification, and, from that moment, each Power will be bound as regards other Powers which have already deposited their ratifications.

127. Protocol Prohibiting the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of Warfare, of June 17, 1925, 94 L.N.T.S. 65; 3 M. HUDSON, INTERNATIONAL LEGISLATION 1670 (1931).
Soon after taking office I directed a comprehensive study of our chemical and biological defense policies and programs. There had been no such review in over fifteen years. As a result, objectives and policies in this field were unclear and programs lacked definition and direction.

Under the auspices of the National Security Council, the Departments of State and Defense, the Arms Control and Disarmament Agency, the office of Science and Technology, the Intelligence Community and other agencies worked closely together on this study for over six months. These government efforts were aided by contributions from the scientific community through the President's Scientific Advisory Committee.

This study has now been completed and its findings carefully considered by the National Security Council. I am now reporting the decisions taken on the basis of this review.

Chemical Warfare Program

As to our chemical warfare program, the United States:

—Reaffirms its oft-repeated renunciation of the first use of lethal chemical weapons.

—Extends this renunciation to the first use of incapacitating chemicals. Consonant with these decisions, the Administration will submit to the Senate, for its advice and consent to ratification. The Geneva Protocol of 1925 which prohibits the first use in war of "asphyxiating, poisonous or other Gases of Bacteriological Methods of Warfare." The United States has long supported the principles and objectives of this Protocol. We take this step toward formal ratification to reinforce our continuing advocacy of international constrains on the use of these weapons.