that children derive from being reared in homes where the mothers have had this education. It argues for more subsidization of the education of females than of males.

7. The Rising Value of Woman's Time. The most pervasive factor that accounts for the required adjustments in social, legal and economic institutions pertaining to marriage, the household, contraception knowledge and the rearing of children is the persistent, marked rise in the value of the time of women. It calls for more flexible marriage arrangements. Consensual marriage prior to entering upon legal marriage is one form of flexibility. The husband and wife working out arrangements so that they can work in different locations is another. Traditional dowries are passe. Equality in the division of the investment portfolio of the family is another step, an arrangement which fortunately is consistent with the incentives provided in federal income and inheritance taxation.

Economizing on the time of women in performing the household work and in managing this enterprise requires all manner of adjustments. The role of consumer durables plays an important part in these adjustments; achievements in this area are impressive. But the state of information about goods and services that households purchase is far from satisfactory. Meanwhile, it is still true that many women are poorly equipped in terms of the level of the education required to manage their households skillfully. In my thinking, the most serious lag is in learning how to live satisfactorily in our age of affluence. The standard of values to be applied to additional things and to one's time, and the standard to be applied in rating the additional opportunities associated with becoming rich, are hard to learn — but learn we must. Not least is the value to be placed on children, the costs of which depend primarily on the opportunity cost of the woman's time.

Would that more women might become top-flight economists and bring the analytical techniques of economics to bear in solving these related issues.

MATTHEW MESELSON

Gas Warfare and the Geneva Protocol of 1925

The example of the world's most modern army using gas for the first time in 45 years and deploying a whole panoply of newly-developed gas munitions in Vietnam cannot help but stimulate the interest of foreign military establishments in the utility of similar weapons. And the proliferation of lethal chemical weapons would greatly enhance the destructive capability of smaller and less wealthy nations. Therefore, it is very much in the U.S. interest to strengthen restraints on chemical warfare and weapons. Matthew Meselson, professor of biology at Harvard University, made the following statement before the Senate Committee on Foreign Relations on March 26, 1971.

I am extremely glad to appear before you today as you consider the Geneva Protocol of 1925, prohibiting gas and germ warfare. Our country's position regarding this category of weapons is very different from what is was two years ago, when I was privileged to come before this Committee in executive session to discuss chemical and biological weapons and their implications for national security. At that time our policies were ambiguous and our weapons programs had taken on a momentum of their own, insufficiently guided by careful analysis of our national interest. It is greatly to the credit of President Nixon and members of his Administration that this dangerous trend has been reversed. Their detailed study and analysis, conducted over a period of more than a year, has given high authority to what is widely sensed by the ordinary citizen: our overriding interest is to reinforce the worldwide restraints against gas and germ warfare. All of the new steps announced by the President have been in this direction — the renunciation of all possession and use of germ and toxin weapons; the reaffirmation of our no-first-use pledge for lethal chemical weapons and its extension to include incapacitating chemical weapons as well; and the submission of the Geneva Protocol to the Senate.

When the Administration began its extensive review, it was faced with a situation in which certain chemical weapons were already in use. Beginning in the early years of our involvement in Vietnam, the use of herbicides and riot gas had grown to very large proportions. But even here there has been an important change. The use of herbicides is now being phased out and the employment of riot gas has fallen to a small fraction of what it once was. Nevertheless, the Geneva Protocol has been submitted to the Senate with a statement by the Secretary of State that it does not apply to herbicides and riot gas. We can understand the reluctance to undertake a no-first-use pledge for weapons so recently and extensively used by our forces. Our concern, however, should not be for what is now rapidly receding but rather for the state of things during the years to come; the ratification of a treaty should try to construct the future rather than justify the past. It is in this spirit that I wish to talk with you in particular about the im-

plications to the United States of our future attitude toward the use in war of riot gas.

(Although the military use of herbicides possesses some of the same implications, it also presents special problems of its own and this very important subject merits separate consideration.)

We must decide whether the military gain from maintaining a first-use option for riot gas is likely to outweigh the benefits of reinforcing the barriers against the use of all gas by others. Let me start by summarizing my conclusions:

1. The military value of riot gas to the United States is very low.

2. Our overriding security interest in the area of chemical and biological weapons is to prevent the proliferation and use of biological and lethal chemical weapons.

3. Our use of riot gas in war runs directly counter to this fundamental interest.

Military Value of Riot Gas

The only riot gas now provided to our forces is CS. It was developed by the British in the 1950s as a more potent agent than ordinary tear gas for dispersing rioters. It is a white solid which can be dispersed in the air as a fine powder or smoke. Exposure to CS causes intense pain in the eyes and upper respiratory tract, progressing to the deep recesses of the lungs where it causes a feeling of suffocation and acute anxiety. Other symptoms include nausea, vomiting and, under humid conditions, irritation of the skin. If exposure is not too intense, these symptoms pass away soon after restoration to fresh air. When used with proper precautions, CS is a relatively safe agent for riot control because there is a large difference between the amount needed to cause brief incapacitation and the amount that causes serious injury or death. When used in combat, where many of the currently employed CS weapons contain much more of the agent than do police-type munitions, CS can cause severe blisters and skin burns that take one or two weeks to heal. Although extreme exposures in some combat situations may exceed the human lethal dosage, the primary effect of CS is not to kill but to incapacitate.

Protection against the ocular and respiratory effects of CS is readily provided by a gas mask. Skin covered with ordinary clothing is fairly well protected against blistering and special ointments have been developed for additional skin protection. The response of unprotected personnel to CS is influenced by their motivation and training. Troops exposed to CS for the first time or who are poorly disciplined often abandon their positions in an attempt to escape the gas. Experienced troops are less likely to leave their positions, but their fighting efficiency will be much reduced. Unprotected troops attacking through a cloud of CS are likely to falter.

In the past five years, a wide variety of CS weapons for air and ground delivery have been developed and deployed in Vietnam. These include grenades, blowers, mortar cartridges, artillery projectiles, rockets and several types of aircraft bombs. These have been used in a number of defensive and offensive roles, including the following:

Defensive: (1) Perimeter defense, in conjunction with other weapons, to disrupt infantry attacks on outposts and other fortified areas. (2) Extraction of downed helicopter crews, by rescue helicopters performing fire-suppression missions with CS and high explosive fire.

Offensive: (1) Flushing enemy troops from cover in conjunction with anti-personnel artillery and air strikes. (2) Reconnaissance by fire, using CS to force concealed troops to reveal their location in the course of attempting to flee the agent cloud. (3) Flushing tunnels and other shelters in the conduct of patrols and infantry sweeps.

A great deal of CS has also been used with the intention of denying terrain and installations to the enemy. For this purpose a special moisture resistant modification of CS has been developed, designated CS-2. For several weeks after the application of CS-2, the movement of ve-

WHERE WE STAND ON RATIFYING THE GENEVA PROTOCOL

The Geneva Protocol has been awaiting ratification by the United States for 47 years. This analysis of its status was given by Matthew Meselson in an address on the occasion of his receiving the University of Chicago Alumni Medal in June 1971.

. . . According to its terms, the Protocol prohibits the use in war of ". . . asphyxiating, poisonous or other gases and of all analogous liquids, materials or devices" and of "bacteriological methods of warfare." More than 90 nations are party to the Protocol, including all important countries except the United States. . . .

In August 1970, President Nixon resubmitted the Geneva Protocol to the Senate as one of several widely praised moves to bring chemical and biological weaponry under control. Hearings have now been held by the Senate Foreign Relations Committee, but the ratification process seems to be at an impass. The problem involves a question of interpretation of just what the Geneva Protocol means. . . .

The question of the status of irritant gas and herbicides dominated the March-April 1971 Senate hearings on ratification of the Protocol. Secretary of State Rogers, testifying on behalf of the Administration, told the Committee that it should recommend ratification of the treaty with the understanding that herbicides and irritant gases are not prohibited. However, several key members of the Committee felt that these special exemptions would perpetuate international disagreement over the meaning of the Protocol and greatly weaken its political and moral force. As a result of these considerations, the Foreign Relations Committee has not submitted the treaty for a vote by the full Senate. . . .

hicles or personnel will reintroduce the agent into the air, causing significant harassment.

An attempt to evaluate the military utility of CS immediately runs into severe difficulties. As Secretary of State William Rogers announced earlier in these hearings, the Administration has recently initiated a systematic field study of this question. At present we have only very limited information, based largely on unstructured interviews with officers and troops. Evaluation is complicated first of all by the fact that CS is almost never used by itself. It is a supplemental weapon, used in conjunction with other weapons. In other words, when CS is used, a great deal more is also going on and it will not be simple to disentangle the many variables. Second, and probably more important, the utility of CS, like that of any gas, depends to an extraordinary degree on whether the enemy is trained and equipped to defend himself.

Using CS

My own impression of the value of CS is based on field interviews done by others in 1968 and numerous conversations I have had with officers and troops in Vietnam and in the United States during the past year. What emerges is that a few years ago the weapon was favorably regarded by most of those who had actually used it, but that today it is used much less and is not highly valued. An artillery commander in the Delta told me that he had simply stopped using CS, while another used it only rarely and thought it of only marginal value. Flying perhaps a dozen gunships and other helicopters, I never once found CS to be on board nor was it stocked at either of two isolated fire bases I visited. Questioning of 30 men with combat experience revealed only two who had ever seen CS used, and then on only one occasion each. A highly experienced Air Force commander thought it was desirable to have on hand as an aid to fire-suppression during rescue of downed helicopter crews, but estimated that it was used for this purpose in fewer than one out of 50 cases. And a high-ranking officer in the Cambodian operation last year considered CS to be of very little importance.

A major factor in the decreasing utility of CS is probably to be found in the response of the enemy. In 1968, a large proportion of NVA (North Vietnamese Army) troops in the northern provinces of South Vietnam had Chinese gas masks, but the VC (Vietcong) were still not well supplied, especially in the South. Last year, according to an Army commander in one of the Delta Provinces, nearly all of the VC troops killed in action were found to carry Chinese gas masks if their bodies had not been previously stripped of weapons.

To summarize, CS seems to have been a useful auxiliary weapon in certain situations when it was first introduced. However its use and its utility have greatly declined, because the enemy has learned to cope with it, especially by equipping his troops with gas masks. Indeed, on numerous occasions he has used CS on a limited scale against us. The implication for the future is clear: if we continue to use CS in warfare, we cause other nations' military forces to examine their defenses. This will stimulate them to procure gas masks and gas weapons. Consequently fewer adversaries and potential adversaries will remain unprotected and unable to retaliate — and the utility of CS to us will decrease proportionately. Still, this in itself is no reason to renounce the first use of riot gas in war. Rather, it furnishes perspective as we inquire into the security benefits of doing so.

More Humane?

But first, it is important to correct a widely-held impression that the use of riot gas makes war more humane. Although the initial use of CS in 1965 was widely seen as a means to separate civilians and soldiers and thereby save civilian lives, in actuality CS has seldom been used for this purpose. A field study conducted in 1968 concludes that this is becaused mixed groups of enemy soldiers and civilians are rarely encountered. The study noted that in the Xth Division area of operation there had been only one known case in which CS was used primarily for its nonlethal character. When civilians have reason to expect a fire fight to break out, they either try to flee or take cover. Paradoxically, when CS is used on mixed groups of military and civilians, it can increase casualties by forcing them from cover into the line of fire.

Neither is CS often used to make war more humane for the other side. Occasionally, the use of riot gas to flush a tunnel has led to the capture of enemy soldiers who otherwise might have escaped or been killed. But these very limited occurrences are greatly overbalanced by the use of CS to enhance the lethal effectiveness of conventional fire power. Indeed, this should come as no surprise. Tear gas was used in World War I, in Manchuria, in Ethiopia, and in Yemen — but not to make those wars more humane. It is unrealistic to expect a soldier to refrain from using the lethal weapons which he has available when doing so may save his life. Troop morale would surely plummet if officers issued any such orders.

Public Opinion

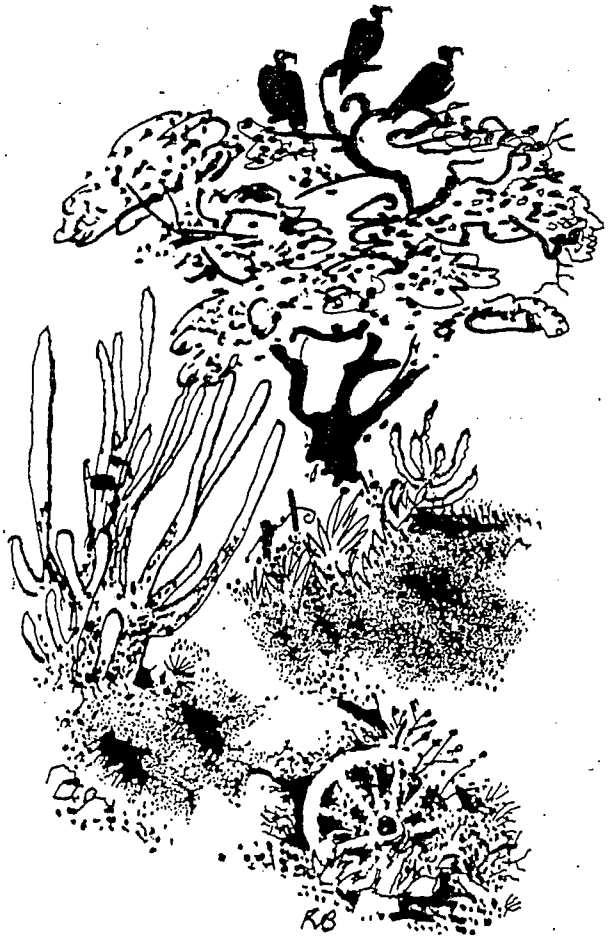
Several factors have operated to discourage nations from initiating chemical warfare and even from making preparations for waging it. Public opinion has regarded chemical warfare as particularly uncivilized and repugnant, an attitude that has been shared by not a few political and military leaders. At the top levels of military planning, chemical weapons have enjoyed little attention or support in comparison with other types of weapons. In the past, most armies have been unprepared to use chemicals. Even when the weapons have been procured and stockpiled, they have been poorly integrated into combat forces and war plans. The few nations which possess chemical weapons have tended to regard them much more as a deterrent against the initiation of chemical warfare by the enemy than as dependable war fighting instruments. Reluctance to accommodate to the costs and complexities of the chemical battlefield and fear of retaliation and escalation have reduced the incentive to initiate chemical warfare.

Thus, psychological aversion, military disinterest, inadequate preparedness and fear of retaliation have acted and interacted to form a complex of

restraints preventing chemical warfare. In the same category and in many ways not clearly distinguished is the use of germs in war — biological warfare. The traditional restraints against chemical and biological warfare are embodied in one of the oldest arms control treaties now in force, the Geneva Protocol of 1925. Its prohibition of chemical and biological warfare under international law adds to the moral and political forces of restraint. In addition, the Protocol places gas and germs in a distinct category, offering a clear and explicit standard upon which nations can base their conduct.

Risks of Proliferation

In the context of both tactical and strategic war it is very much in the U. S. interest to preserve and strengthen the restraints that prevent chemical warfare and the proliferation of chemical weapons. Today "limited wars" are fought with conventional weapons which individually have limited area effect. Such weapons can be decisive only when very great quantities are available. The wealth of the United States allows us to expend enormous quantities of conventional munitions in tactical combat. Very few countries even approach this capability. However, the proliferation of lethal chemical weapons would greatly enhance the destructive capability of smaller and less wealthy nations. This is because chemical weapons have the potential of large area coverage at relatively low cost. Many of the types of munitions used in limited war can be filled with lethal chemicals instead of explosives. The "kill area" of lightweight munitions such as mortar cartridges and rockets would thereby be increased by a large factor. Modern lethal gas weapons can be made by many countries. They can be supplied to small nations and dissident forces by their big-power allies. Even though defending troops can be provided with protective masks and suits, such weapons would be devastating to military units caught off guard and to the civilian population. In many situations lethal chemical weapons would favor guerrilla forces. Such forces generally have no shortage of targets. They know the locations of military installations such as base camps and support facilities. Their problem is their great inferiority in fire power. For anti-guerrilla forces the reverse is usually true, their main tactical problem being location of the enemy. In this situation any major enhancement of the area coverage of lightweight weapons disproportionately favors less sophisticated forces operating in smaller units capable of dispersing over large areas or mingling with the civilian population. Moreover, the proliferation of lethal chemical weapons would create greatly expanded opportunities for terror attacks on urban centers by small groups of men firing chemical rockets or mortars from the outskirts. Thus, the proliferation of chemical weapons would seriously reduce the military advantage that great wealth confers, while at the same time threatening a major increase in the violence of war and its toll among civilians.



At the strategic level the hazard of proliferation of lethal gas weapons is also serious. Countries not possessing nuclear weapons might be tempted to acquire a population-killing capability based on nerve gas. Under suitably chosen meteorological conditions, a small bomber force could deliver enough nerve agent to kill a large proportion of persons in a major city. Although it is unlikely that a poor nation could successfully deliver chemicals over a wide area of a country with modern air defenses, it would be difficult to defend against a surprise attack on one or a few coastal cities. Further, it should be noted that the proliferation of chemical weapons is likely

to stimulate interest in the strategic possibilities of biological weapons and that the economics of anti-personnel and anti-crop biological weapons for threat or deterrence may come to seem particularly attractive to less wealthy nations.

To summarize, the proliferation of lethal chemical weapons would risk a major increase in the level of death and devastation in wars of all kinds. Proliferation would provide forces less wealthy and sophisticated than the United States with greatly enhanced capability for threat, harassment and destruction. The acquisition of chemical weapons would stimulate interest in biological weapons, for the barriers against both are intertwined. The overriding objective of the United States in this area of policy should be to prevent the proliferation of chemical and biological weapons and to strengthen the barriers against their use.

U.S. Example as Stimulus

The example of the world's most modern army using gas for the first time in 45 years and deploying a whole panoply of newly-developed gas munitions cannot help but stimulate the interest of foreign military establishments in the utility of similar weapons. Military planners in other countries would be remiss in their duty if they did not carefully study the use of riot gas in Vietnam. If we retain our first-use option for this weapon, others must give more serious attention to analysis and planning for chemical defense and chemical warfare. At a minimum, they will be motivated to procure gas masks and intensify chemical training. Having done this, the additional cost of acquiring a lethal chemical capability is reduced. As more armies become accustomed to training in a chemical environment, as chemical cadres are upgraded and careers become dependent on a role for gas, the next step leading to acquisition of lethal chemicals becomes smaller and harder to resist. Many of the techniques for the dispersal of riot gas are similar to those employed for lethal chemicals, so that the progression to an offensive lethal capability would be facilitated. Thus, over time, the consequences of the use of riot gas in war will cause nations less wealthy than we to take more seriously the possibilities of lethal gas.

If the proliferation of lethal chemical warfare readiness gets underway, escalation on the battlefield becomes a very real danger. Having become accustomed to the use of riot gas, other nations may be less inhibited than the United States in progressing on to lethal chemicals. The experience in Yemen, where riot gas was used before poison gas, appears to be an example of such escalation. Indeed, the use of riot gas apparently preceded the escalation to lethal agents in every case where lethal agents have been used — in Manchuria, in Ethiopia and in Europe during World War I. The use of harassing gas paves the way by providing experience and establishing defensive preparations and logistic arrangements that can facilitate the transition to other more toxic gases. Once the other side deploys gas masks, riot gas loses almost all of its effectiveness. An obvious response in that case would be to employ skin irritants, which could include relatively subtle modifications of existing riot agents. The move to more toxic skin agents such as mustard gas may not seem as great as the step of introducing harassing agents in the first place. Another source of pressure to move upward in the scale of toxic weapons could be born of desperation to retrieve a deteriorating battlefield situation where defeat would have serious political repercussions. Even if both sides in a conflict were to tacitly agree to limit themselves to nonlethal agents, there may be serious difficulty in finding a mutually agreeable and workable standard, particularly as the steady advance of technology generates more agents with novel effects.

Geneva Protocol

In December 1969 the United Nations General Assembly by a vote of 80 to 3 with 36 abstentions adopted a resolution holding that the Geneva Protocol prohibits the use in war of all toxic chemicals against man, animals or plants. It was made clear in the debate that agents like CS were included within the meaning of the resolution. The three negative votes were cast by the United States, Australia and Portugal. In view of the U.N. resolution, there appears little likelihood of securing widespread agreement to exempt riot gas from the Protocol. However, if we were to relinquish our first-use option for this weapon, as we have already done for all other gases, we could almost certainly obtain overwhelming international agreement on the applicability of the Protocol to all anti-personnel chemicals, without exception.

The cost of continued division regarding the scope of the Protocol is to weaken its political and psychological effectiveness and to block progress toward more farreaching agreements to prevent the proliferation and use of both chemical and biological weapons.

Weighing Utility

The utility of our option to use riot gas in combat has to be weighed against the costs it imposes by stimulating the proliferation of chemical warfare capability and by perpetuating international disagreement regarding the meaning of the Geneva Protocol. When it was relatively new to the battlefield riot gas was in certain situations a useful adjunct to other weapons in Vietnam. But now its value has decreased to a low level, chiefly because the enemy has acquired gas masks and learned to cope with gas tactics. If we continue to use CS and to integrate it into our combat forces, fewer of our present and potential adversaries will remain unequipped with gas masks and gas weapons. As this happens, the utility of CS to us will decrease proportionately. In contrast, our interest in preventing the proliferation of chemical weapons will continue and intensify with the increasing capability of more nations to produce modern weapons once considered accessible only to the most technologically advanced countries. It would appear, therefore, that our long-term interest is to repair to the traditional standard of not using gas weapons of any kind in war. If this is so, we should attempt to ratify the Geneva Protocol in a manner that will allow us to support a broad interpretation of its scope to which all nations can agree.