One Scientist Speaks Up

ALBERT SCHWEITZER's appeal to the scientists to speak up "about the problem of the effects of H-bomb explosions" [*Science* 120, 11A (10 Sept. 1954)] will be heeded by many. No one will respond lightly to this challenge. Everyone will share the horrible fear of a war in which these weapons would obliterate the populations of very large areas and make uninhabitable for some time whole states or countries. Everyone also will expect the utmost precaution against further accidents resulting from tests.

Yet a distinction must be made between the threatened wartime use of nuclear bombs and the test explosions in the East and West. In the latter cases the issue is not that of wholesale destruction of lives but of the possible biological consequences slowly acting on the well-being of present and future generations. The radioactive particles that are formed during the explosions are carried high up into the atmosphere and fall out gradually over the whole globe. They surround us and are taken up by human bodies in breathing and feeding. How do they affect personal health and that of future generations?

This question, as far as it can be answered at all at present, must be answered on two different levels, an absolute and a relative one. On the basis of experience with medium and high doses of irradiation many biologists and medical men will be inclined to believe that even low dosages increase the probability of illness in individuals exposed to radioactive fall-out. For any one person the increase in probability is small indeed, but considering all mankind the production of a number of detrimental or fatal disease incidents may be expected. Likewise, most geneticists are inclined to extrapolate the evidence from medium- and high-dosage irradiation and to postulate that even very low doses produce genetic changes, mutations. Probably all will agree that many mutations are unfavorable to their carriers. Frequently the degree of detrimental action may hardly be measurable on an individual basis, although it may show a slight average effect in large numbers of individuals. This may be true even for the great class of recessive lethal mutations that kill in homozygotes but may often well be eliminated without obvious harm in the course of the generations during which they are carried in heterozygous individuals. In an absolute sense, however, it is probably true that a fraction of the induced mutations will cause future misery and death just as a fraction of the individuals of the present generation may later suffer from the direct effects of fall-out exposure.

This absolute statement has to be complemented by a relative one. In each generation of mankind many millions of individuals are born who from birth on or later in life are affected with genetically controlled slight, severe, or fatal disorders. Most of these afflictions are the expression of "spontaneous" mutations that occurred long ago and have been carried invisibly for many generations. A few afflictions are due to recent "spontaneous" mutations in one of the normal parents of the genetically ill individual. The causes of "spontaneous" mutability are varied and beyond human control: physicochemical irregularities within the germ cells, background irradiation from cosmic rays, from the natural radioisotopes of potassium and other elements, and from substances like radium.

As long as the number of test explosions remains small the total irradiation from fall-out received by an individual and his germ cells will cause only a vanishingly small fraction of the individual illnesses that afflict the present generation and an unknown fraction of the number of those mutations that originate spontaneously in each generation. Most of the induced mutations will not express themselves immediately but will appear here and there over the course of hundreds of future years. It is safe to predict that no census data will show an increase of present or future afflictions due to a carefully limited number of test explosions. Relatively then and in terms of mankind as a whole the biological consequences of controlled test explosions are very small.

The moral problem remains. Each individual case of harm or death due to fall-out, in our time or in the distant future, places a burden on our conscience. But again these cases must be weighed in a balance. We use automobiles although they are the cause of thousands of maiming and killing accidents each month. We employ x-rays although they must lead to personal damage to some and cause mutations that might produce harm in the future. We inhale industrial wastes although they may well shorten our lives. While we attempt to decrease the damage, we do not propose to abolish automobiles, x-ray machines, and chemical industry. The question of whether or not nuclear tests are of ultimate benefit to mankind is partly one of political opinion and partly one of scientific prophecy. For the political aspect the scientist's views cannot claim greater attention than those of other citizens. If the tests cause benefits the harm also done must be evaluated in relative terms. Should the tests lead to peaceful applications the gain to mankind may be greater than that from all inventions of recent centuries.

It is to mankind's shame not to have yet banished even the thought of war. Schweitzer's "anguish in my heart" must be felt by all of us. The scientists cannot cease to tell humanity the terrible truth about nuclear war, but the tests themselves pose much lesser problems.

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