Comments on the article "The Fallout Scare", by Edward Teller with Allen Brown, Part 2 of a series of three published in the Saturday Evening Post, February 3, 10, and 17, 1962

by Linus Pauling, prepared for communication to Hans Bethe

It is my opinion that this article is written in such a way as to mislead the readers in a serious manner.

For example, there is a subheading at the top of page 36, in large type, as follows: "Radiation from test fallout might be slightly harmful to humans . . . or slightly beneficial."

The emphasis given to this statement would cause readers to think that the radiation from test fallout might, in fact, be slightly beneficial to the human race, rather than harmful. This is contrary to fact. All geneticists agree that the radiation from test fallout causes a small increase in the rate of gene mutation, and that this is harmful, because the overwhelming majority of mutated genes are harmful. The genetic effect of radiation from test fallout is harmful. As to the somatic effect, there is a widespread opinion among biological scientists that the fallout radiation probably causes some increase in incidence of leukemia, bone cancer, and other diseases, such as to decrease life expectancy. Most investigations with animals have shown that high-energy radiation produces a decrease in life expectancy. One investigator has reported a small increase in life expectancy. In my opinion there is a very small probability that radiation from test fallout is, in its somatic effects, slightly beneficial, and a very large probability, close to unity, that it is slightly harmful to humans, in its somatic effects. "Slightly harmful" means that a few people may be caused to die 5 or 10 or 15 years earlier than they would have died if bomb tests had not been carried out, because of damage to their cells by the radiation from bomb tests. The genetic effect of radiation from test fallout can only be described as harmful.

The first sentence in the article is "Fallout from nuclear testing is not

worth worrying about." This is a matter of opinion. It has been my opinion that it is worth worrying about. You probably know that the estimates that I have made about the number of grossly defective children that will in the course of time be born because of the mutagenic action of the radioactive materials produced by the bomb tests carried out so far is of the order of magnitude of one million.

The second sentence is "Its effect on human beings, if there is an effect, is insignificant." Here I feel that it is truly misleading to include the clause "if there is an effect", because it is known that there is a genetic effect. To describe the effect as insignificant is an expression of opinion by Teller. I do not consider that an effect that may mean great suffering for as many as a million children and also for their parents is insignificant.

After stating that human beings are now being exposed to about 0.003 roentgen per year from strontium 90, cesium 137, etc., and that natural high-energy radiation gives a much larger exposure, varying from place to place, Teller makes statements such as the following: "Exposure to cosmic rays in Denver, about 5000 feet above sea level, is 0.05 roentgen a year. If such small doses of radiation really are dangerous, we had better evacuate Denver. . .radiation from radium in the drinking water in some parts of the United States has been observed as high as 0.005 roentgen a year. If such small amounts of fallout radiation really are dangerous, people in some United States communities should stop drinking their local water. . . Brick contains more natural radioactivity than wood. . . If worldwide test fallout really is dangerous, we should tear down all of our brick houses. . . we should throw away bedside alarm clocks with dials that can be seen in the night, because they are spraying the occupants of the bed with radiation. . . we know that worldwide fallout is not as dangerous as living in Denver rather than San Francisco, that it is not as likely to induce cancer as smoking a pack of cigarettes a day, that it is not as likely to give

rise to harmful effects as are many unsuspected chemicals in the food we eat or in the air we breathe, that it is not as apt to produce mutations as wearing trousers. It is, in other words, not worth worrying about."

My principal objection to statements of this sort is the use of the word dangerous, which is interpreted differently by different people. Teller does not say that fallout radiation does not do damage (at any rate, he does not say so in these paragraphs). He does not mention that it is believed that a great deal of damage is done to human beings by the natural high-energy radiation, from cosmic rays and natural radioactivity. About four million babies with gross congenital defects are born each year. The average estimate of leading geneticists is that about five percent of the congenital defects are caused by natural high-energy radiation. This means that the background radiation, averaging about 0.1 roentgen per year, is responsible for the production of about 200,000 grossly defective children each year.

If, during generation after generation, the reproductive organs of human beings were to be irradiated by an additional amount of radiation equal to the background radiation, the mutation rate would be increased by an estimated ten percent, and in the course of time a new steady state would be reached in which the number of defective children born because of gene mutations would be increased by ten percent. It is usually assumed that half of the congenital defects are the result of gene mutations, and accordingly this would produce a five percent increase in the number of defective children, corresponding to an additional 200,000 per year.

The usual estimate of increased irradiation of the reproductive organs is that if testing were carried out at the rate of ten megatons of fission per year, the fallout radioactivity would, when the steady state had been reached, amount to 0.010 roentgen per year, ten percent of the background radiation. This would cause an increase, when the steady state was reached, of one percent in the number

of defective children caused by mutated genes, or one half percent in the number of children with congenital defects. With children being born at the present rate, it would amount to 100,000 children per year born with gross physical or mental defect as a result of the bomb tests. This corresponds to 10,000 per megaton of fission in the atmosphere.

The statement by Teller that human beings are now receiving about 0.003 roentgen per year from fallout is compatible with the statement that ten megatons of fission per year would produce a steady-state increase of 0.010 roentgen per year. If no more bombs were to be tested in the atmosphere, human beings now living and newborn children would continue to be irradiated, for many decades, with an amount of radiation from fallout fission products approximately equal to that at present, 0.003 roentgen per year, but falling off toward zero during the next century.

In addition to the effect of the fission products, the effect of carbon 14 must also be considered. I enclose a paper that I published in Science on this effect. The estimates that I made of the effects of bomb-test carbon 14 are very close to those made independently by Totter, Zelle, and Hollister, of the Atomic Energy Commission, and also published in Science. The paper is reproduced in the 1959 hearings before the Subcommittee of the Joint Congressional Committee on Atomic Energy.

You no doubt have noticed the various misleading sentences in the Teller articles--sentences written in such a way that they cause the reader to reach an erroneous conclusion. An example is the sentence "But the effect of fallout on the mutation rate has not been observed." It is very difficult to measure mutation rate in human beings--that is, to observe mutation rate. The reliability of medical statistics on incidence of congenital defects is such that even a ten percent increase in the mutation rate, from 1954 on, would not be detectable. It would not lead immediately to a ten percent increase in the number of congenital defects,

during the first generation, but to a much smaller increase. Nevertheless, the statement that the effects of fallout on the mutation rate has not been observed, made by Teller, strongly suggests to the reader that there is no effect of fallout on the mutation rate.

Another such sentence is "Even higher doses would be required to increase noticeably the number of mutations." This sentence, too, strongly suggests to the reader that fallout radioactivity does not increase the number of mutations. The statement would be false, of course, if the adverb noticeably were not included in it.

Another example of a misleading statement is the sentence "An exposure to ten times the maximum-permissible dose certainly can be tolerated." What does Teller mean when he says that something can be tolerated? Would he consider that tripling the number of grossly defective children born could be tolerated? The exposure that he is talking about in this sentence, which he describes as forty times background radiation, would, if all people received it, lead ultimately to a three-fold increase in the number of defective children, according to the estimate quoted above that background radiation is responsible for five percent of congenital defects.

What does Teller mean by the word insignificant? His use of this word is an expression of personal opinion, the opinion that the effect of radioactive fallout in causing physical and mental defects in children is in his opinion of no significance or importance. Nowhere in his article does he provide the reader with any information about the number of affected children, which would permit the reader himself to decide whether he considered the biological effects of radioactive fallout to be insignificant.