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Background radiation as the cause of fatal congenital malformation

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Commenting on the letter of Spiers *et al.* (*Int. J. Rad. Biol.*, **2**, 235) it would be interesting if observational evidence existed which was adequate enough to indicate that there is no sizeable geomagnetic latitude variation in background radiation. The sketchy evidence available is, unfortunately, not very convincing when compared with the following reasons for believing that ground radiation must have a sizeable geomagnetic latitude variation: First, cosmic-rays, which have about a 10 per cent latitude variation at sea level, have been irradiating the ground for millions of years. Second, cosmic-rays which produce radioactive elements in the atmosphere have a large geomagnetic latitude variation; and the resulting fallout debris has been accumulating on the ground for millions of years. Third, huge quantities of cosmic dust made radioactive in outer space have been accumulating on the earth's surface for millions of years; particulate matter being almost always charged (plus or minus) in outer space will tend to follow magnetic field lines to earth, thereby yielding a large geomagnetic latitude effect.

The problem of determining the precise nature of cosmic-ray-produced radioactive fallout is not simple. If the distribution of the primary cosmic-rays from protons to uranium nuclei were known, if the latitude variation for each of these particles were known, if the energy spectrum of each of these particles were known, and if the various possible reactions of these particles with electrons, oxygen, nitrogen, and hydrogen were known, then one could determine the species of radioactive elements which drift to earth as fallout and what their individual latitude variations are. It is interesting to note that the latitude variation becomes much greater with increasing mass of the primary cosmic-ray particle (Peters, B., 1951, *Progress in Cosmic Ray Physics*, Edited by Wilson, J. C. (New York: Interscience Publishers), Vol. I, pp. 193–242).

Local geologically produced fluctuations in ground radiations (such as noted in India and Brazil), being much greater than the total latitude variation, tend to mask the overall average pattern.

The biologically-effective background radiation was assumed to be proportional to the total cosmic-ray energy flux merely as the simplest possible theory. This assumption does not make the author particularly happy, as only a proper geophysical survey, with measurements taken at predetermined points on a grid, might determine what the geomagnetic latitude variation in background radiation actually is. Such a survey would also be of interest in geophysics and cosmogony. To obtain the biologically-effective background, internal radiation should also be sampled in various countries (perhaps, by placing counters or ionization chambers in various tissues of cadavers).

The large rate of congenital malformation in the Jewish population in Israel, which fails to fit into the overall European pattern, can probably be attributed to the North European origin of a large fraction of the Jewish population—the

rate of congenital malformation being high in Northern Europe. The high rate in Malta remains unexplained.

Perhaps, the large background radiation in ' some Brazilian states ' accounts for the unexpectedly large (for that latitude) rate of congenital malformation of 3·55 deaths per thousand births in the Federal district of Brazil.

In the light of experimental results obtained by irradiating animals and of the work of Gentry *et al.* in New York State, U.S.A., in correlating the variation of the incidence of congenital malformation in humans with a corresponding variation in background radioactivity (Gentry, J. T., Parkhurst, E., and Bulin, G. V., 1959, *Amer. J. Publ. Hlth*, **49**, 4), it must be accepted that background radiation is responsible for at least *some* human congenital malformation. It would be very interesting if another mechanism, known to occur in nature, could be discovered to account for the *remaining* congenital malformations. It would also be of some interest if this mechanism could account for the correlation of fatal congenital malformation with geomagnetic latitude, a correlation which, apparently, is not disputed.

My theory does not claim that the background radiation at the geomagnetic equator should be zero.

If it is ascertained by observation that the latitude variation of the total background radiation is not sufficient to account for the variation in the incidence of congenital malformation, and if the medical data are correct, then because of the demonstrated effects of radiation I would be inclined to consider the individual latitude variations of trace radioactive elements which might have specific biological effects causing congenital malformation.

Two criticisms of my paper are pertinent:

There is a discrepancy between the value of roughly 10 per cent of naturally occurring congenital malformations being attributed to background radiation, as obtained by extrapolating from the experimental observations on irradiated *Drosophila* and mice, and the value of 100 per cent assumed in the paper. Apart from the almost impossible task of trying to translate the data to humans, the relation between radiation and the death rate due to lethal genes can become complicated. For example, consider the hypothetical case of a dominant gene which is lethal 50 per cent of the time (depending upon various chromosome combinations). Two deaths are required to get rid of one such gene from the population, assuming all parents have the same number of surviving offspring. To introduce such a gene into the population by the action of radiation one first-generation death is required. If equilibium is maintained, as many such genes entering the population as leaving it, there will be 3/2 times the death rate due to this gene as compared with the death rate produced by a 100 per cent lethal dominant gene (assuming mutation rates the same for all lethal genes). The death rate attributable to background radiation can, therefore, be higher than would be expected from a simple extrapolation of the data obtained from irradiated fruit flies and mice.

My paper fails to give a precise specification of the accuracy of the medical statistics and, therefore, fails to indicate the probability that the observed variations in the incidence of congenital malformation might not be merely a medical statistical artifact. The discovery of a way to properly estimate the probability of the existence of an artifact by constructing a measure of reliability from the existing medical statistics would be most welcome.