other animals showed that the electrode track had penetrated deeper into the septal area of this animal than it had in the others. This animal, like the others, showed no habituation of the heart-rate slowing response. No statistically significant change in heart rate was observed during extinction in any of the animals. Subject 10 pressed only briefly with relatively long intervals of nonpressing between bar-presses (acquisition and extinction percentages were 15.0 and 2.7, respectively, as compared with percentages of 40.7 and 12.6 for subject 6). Histological findings for subject 3, dropped from the experiment after one session for lack of promise, showed failure of the electrode to penetrate through the *corpus callosum* into the septal area. In subject 4, when experimenter-produced and self-stimulations from the one available session were combined, the difference between heart rate immediately before and immediately after stimulation was a statistically reliable one (again in the direction of heart-rate slowing after stimulation). In summary, all six animals with positive histological findings (that is, electrode track in the septal area) showed significant slowing of heart rate upon stimulation.

The results clearly show that septal stimulation, whether self-produced or presented by the experimenter, had the very consistent effect of slowing the rate at which the heart was beating. As far as heart rate is concerned, therefore, septal stimulation produced a parasympathetic or quieting effect with reinforcing properties. This finding is of interest in relation to the result of the study by Brady and Nauta (*3*) which, as Olds and Milner noted, "suggests that the septal area is a quieting system, for its surgical removal produced an extremely active animal" (*2*, p. 426).

The fact that a consistent, objectively recordable physiological change of this kind occurs in association with the act of septal self-stimulation is encouraging with respect to further experimental inquiries into the nature of reinforcement produced by intracranial stimulation, and into the problem of reinforcement generally (*4*).

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Fallout from Nuclear Detonations of February and April 1960

Abstract. A sharp increase in the ratio of strontium-89 to strontium-90 in rain was observed at Fayetteville, Arkansas, after the French nuclear detonations of February and April 1960. Experimental data obtained suggest the possibility that part of the debris from atom bombs detonated in the tropical region may enter the stratosphere.

It is generally accepted that atom bombs, such as those detonated at Reggan in the Sahara Desert on 13 February and on 1 April 1960, inject their debris solely into the troposphere, whereas debris from hydrogen bombs enter the stratosphere and cause the world-wide stratospheric fallout.

Although the French nuclear detonations caused seemingly small transient increases in fallout and the fresh debris will most likely add no more than a few tenths of a percent to the total world-wide fallout of long-lived fission products, the radioisotope injection into the atmosphere by the French nuclear detonations was of unique scientific interest in that the nuclear explosions occurred in the tropical region after a long suspension period of nuclear testing.

According to the global circulation model of air masses, proposed by Brewer and by Dobson (*1*), there is an upward flow of air in the tropical region, and hence a material transfer from the troposphere to the stratosphere is expected to occur. Thus, part of the debris from the atom bombs detonated in the tropical region may enter the stratosphere.

Kuroda and his co-workers (*2*) reported the results of the measurements of the ratios of radioisotopes in rain and snow collected at Fayetteville, Ark., during the nuclear test suspension period, which lasted for approximately 16 months after November 1958. As a result of these studies, we have obtained fairly accurate knowledge of the relative ratios of a number of fission products in the stratosphere prior to the French nuclear detonations.

We have continued the measurements of the barium-140, strontium-89, and strontium-90 contents in individual samples of rain and snow collected at Fayetteville, Ark. Radiochemical procedures used were essentially the same as those described by Kuroda (*3*). Because of the extremely small concentrations of the fission products in some of the recent rain samples, usually

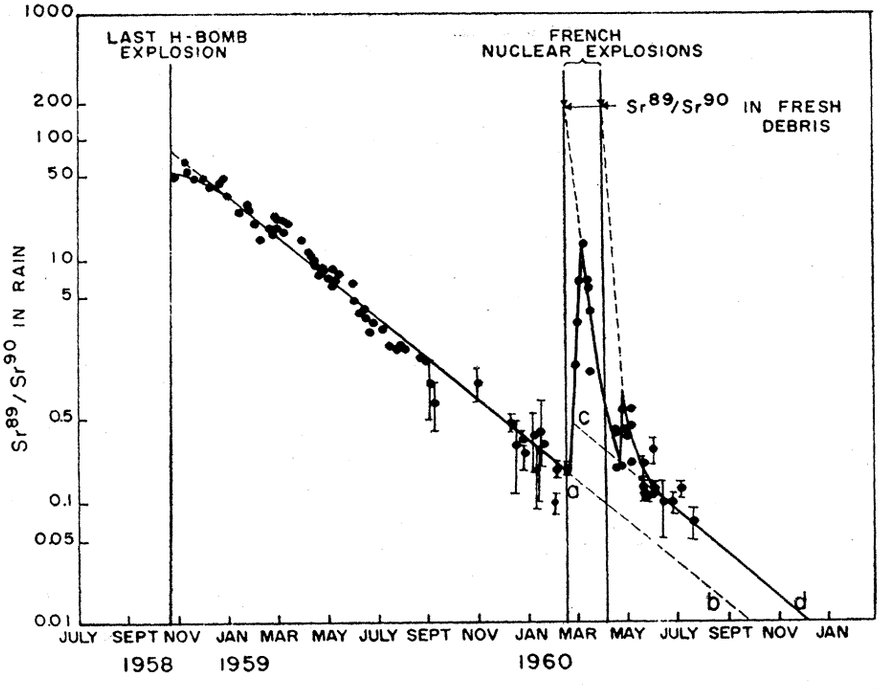

Fig. 1. Variation of the ratio of strontium-89 to strontium-90 in individual samples of rain and snow collected at Fayetteville, Arkansas, since November 1958.

4, but sometimes 8 liters of samples were taken for the radiochemical analyses.

Figure 1 shows the variation of the Sr^{89}/Sr^{90} ratio in rain. A sharp increase in the ratio was observed 10 days after the first French nuclear explosion, and the ratio reached a maximum approximately 3 weeks after the explosion. The second peak which followed the April explosion was small and not too well defined.

Results from our previous studies predicted that the Sr^{89}/Sr^{90} ratio in the stratosphere after February 1960 would have been something like the dotted straight line *ab* shown in Fig. 1, if the February and April nuclear explosions had not taken place.

If the debris from the French nuclear detonations did not enter the stratosphere, the Sr^{89}/Sr^{90} ratio in rain should have asymptotically approached the straight line *ab* 1 to 2 months after the April nuclear explosion. Figure 1 indicates, however, that a new Sr^{89}/Sr^{90} ratio, given by the straight line *cd*, was established in the stratosphere after the French nuclear detonations. This can be explained by the fact that some of the Sr^{89} and Sr^{90} atoms produced by the French nuclear explosions were transported from the troposphere to the stratosphere by the upward flow of air in the tropical region, described by Brewer and by Dobson (*1*).

It is possible to make a rough estimate of the increase in the stratospheric Sr^{90} inventory due to the French nuclear explosions. If it is assumed that the February explosion was chiefly responsible for the increase in the stratospheric Sr^{90} inventory, the Sr^{89}/Sr^{90} ratio in the stratosphere has increased from 0.15 ± 0.05 (curie/curie) to 0.5 ± 0.1 (curie/curie) because of this nuclear explosion. It is known that the fissionable material used in the bomb was plutonium. The Sr^{89}/Sr^{90} ratio in a fresh fission products mixture from a plutonium bomb explosion can be calculated to be approximately 170 (curie/curie), and hence

$$\frac{(0.15 \pm 0.05)P + 170\,Q}{P + Q} = (0.5 \pm 0.1) \qquad (1)$$

where P is the total quantity of Sr^{90} in the stratosphere prior to the nuclear explosion and Q is the quantity of Sr^{90} which entered the stratosphere from the French nuclear detonation. Solving Eq. 1 for Q/P, a value

$$Q/P = 0.0021 \pm 0.0009$$

is obtained.

It is possible that the April explosion was chiefly responsible for the increase in the stratospheric Sr^{90} inventory, and similar calculation yields a value

$$Q/P = 0.0010 \pm 0.0003$$

for this case. Thus, it would appear that the percentage increase in the Sr^{90} inventory of the Northern Hemisphere due to the French nuclear explosions was approximately 0.1 to 0.2 percent (*4*).

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Blockade of Deoxyribonucleic Acid Synthesis by Deuterium Oxide

Abstract. Interference with deoxyribonucleic acid replication need not be a *primary* mechanism in the blockade of cell division by deuterium oxide, but current hypotheses on the molecular basis of the blockade do suggest that such interference might take place under appropriate conditions. Autoradiographic experiments support the suggestion, for whereas normal sea urchin eggs incorporate H^3-thymidine into deoxyribonucleic acid from almost the beginning of development, cells immersed in deuterium-enriched media do not. Blockade of mitosis and inhibition of thymidine incorporation are simultaneously relieved when the eggs are returned to normal water.

Disturbances of cell division are the most obvious of the growth-inhibiting effects of heavy water on microorganisms. These effects have been the objects of several investigations (*1*). Katz and his co-workers have been able to adapt algae to growth in 99+ percent D_2O, and Flaumenhaft *et al.* observed changes in the patterns of nucleic acid synthesis and distribution in deuterated *Chlorella* and *Scenedesmus* (*2*). Serious disturbances of cell division follow also upon exposure of higher organisms to D_2O (*3*). Gross and Spindel (*4*) have found that D_2O inhibits reversibly the mitotic division of marine invertebrate eggs, and that the inhibition can be imposed at any stage, including even cytokinesis. Their interpretation of the data emphasizes a cooperative deuterium isotope effect upon the operation of multiple hydrogen-bonded structures in the cytoplasm, among them the mitotic apparatus and the cleavage furrows.

Calvin and his associates have supposed that cooperative effects of this type might appear at the molecular level, importantly so in the synthesis and function of proteins and nucleic acids (*5*). Since mitotic inhibition by D_2O can be effected in the sea urchin egg *after* deoxyribonucleic acid (DNA) replication is complete, and indeed long after metaphase (*4*), such a mechanism cannot alone account for the mitotic block. Yet cytochemical evidence does suggest alterations of nucleic acid synthesis in deuterated algae (*2*), and it is therefore of interest to determine whether DNA synthesis is affected by deuteration of cells other than microorganisms.

For theoretical and practical reasons (*4*), the sea urchin egg has been chosen for this work. A test of the hypothesis that DNA synthesis is affected by deuteration is afforded by autoradiography of cells exposed to tritiated thymidine during the period of DNA replication. Harding and Hughes (*6*) and Bucher and Mazia (*7*) have already shown that H^3-thymidine is incorporated into polymers during the early cleavages of sea urchin eggs, and the temporal relations between isotope incorporation and the appearance of mitotic figures have most recently been studied in injured lens epithelium by Harding and Srinivasan (*8*).

Eggs and sperm of *Arbacia punctulata* were obtained in the usual way. A large population of eggs (with jelly coats removed) was inseminated in normal sea water at 21.5°C. Exactly 5 minutes later, when 95+ percent of the cells had elevated normal fertilization membranes, the population was divided, half of the cells being placed in filtered sea water containing H^3-thymidine and the other half in a reconstituted deuterium sea water (90+ percent of D) containing H^3-thymidine. The thymidine had a specific activity of 1.9 c/m mole and was present in both incubation media at a level of 8.33 μc/ml.

Samples were removed from the cultures to acetic-alcohol and dilute formalin fixatives at brief intervals, beginning with the time when the control eggs (in normal sea water and thymidine) reached 50 percent first cleavage. One hundred and eight minutes after fertilization, when the controls were dividing from four to eight cells (the deuterated cells still undivided), the D_2O-treated population was freed of excess deuterium by repeated centrifuga-