so that probably several per cent. remain of the original accumulation of H^2. After purifying the remaining water its excess density proved to be 0.000085, or in other words, at least 0.000097 of the original excess density was due to H^2.

Another part of the same sample was treated with sulfur dioxide, which removes the excess of oxygen isotope by a corresponding reaction

$$H_2O^{18} + SO^{16}O^{16} = H_2O^{16} + SO^{16}O^{18}$$

In this case the sulfur dioxide was allowed merely to bubble through the water for several days. The excess density of the residue was 0.000109, showing that of the original density excess at least 0.000073 was due to O^{18}. We thus account for 0.000170 of the original 0.000182. This crude experiment shows that with a little refinement we shall have an exact method for analyzing water containing isotopes of both oxygen and hydrogen. In work of precision the isotopic composition of the ammonia must be ascertained, especially if it is prepared from electrolytic hydrogen, and precautions must be taken against any large loss of water by evaporation.

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GILBERT N. LEWIS

RECEIVED JULY 22, 1933 PUBLISHED AUGUST 5, 1933

THE BIOCHEMISTRY OF WATER CONTAINING HYDROGEN ISOTOPE

Sir:

Even before I had succeeded in concentrating the isotope of hydrogen, I predicted that H^2H^2O would not support life and would be lethal to higher organisms. As soon as heavy water became available experiments to test this idea were begun, but it was necessary to choose an experiment which would require the minimum of biological technique and also very small quantities of water.

The minute seeds of tobacco (*nicotiana tabacum var. purpurea*), which Professor C. B. Lipman has kindly furnished me, were found to germinate almost infallibly under favorable conditions. I then placed twelve of these seeds in pairs in

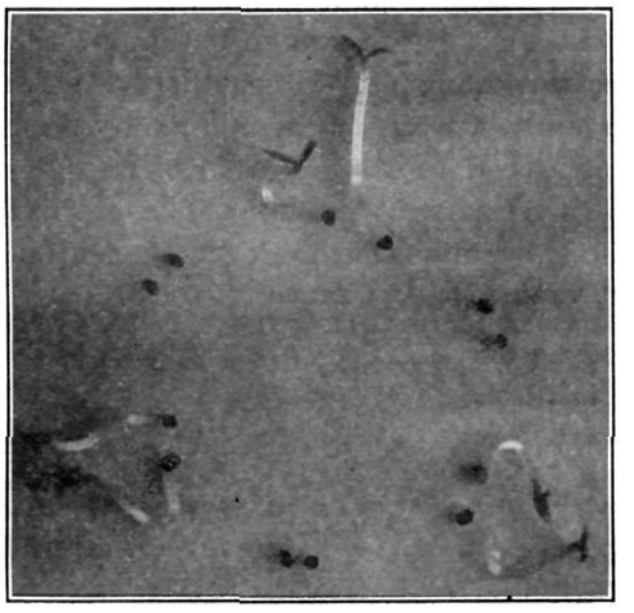

Fig. 1.

six similar glass tubes and added to each of three tubes 0.02 cc. of ordinary distilled water and to each of the other three tubes 0.02 cc. of pure H^2H^2O. The six tubes were then hermetically sealed and placed in a thermostat at 25°. The three pairs of seeds in ordinary water began to sprout in two days and at the end of two weeks formed the well-developed seedlings shown in Fig. 1. The three pairs of seeds in H^2H^2O showed, at least macroscopically, no development. These three pairs alternate with the seedlings in Fig. 1. These undeveloped seeds have now been restored to ordinary water and it will be interesting to see whether their development has been only inhibited or whether they have been killed.

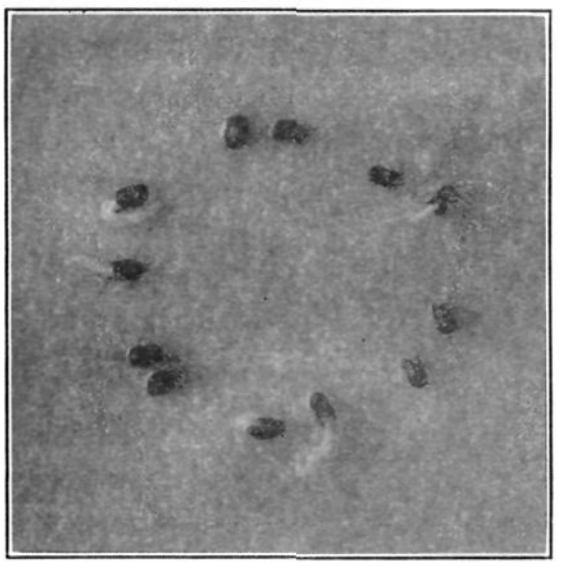

Fig. 2.

Six entirely similar tubes, each containing two seeds, were filled alternately with ordinary distilled water and with water in which one-half of the hydrogen is H^2, thus corresponding, on the average, to the formula H^1H^2O. At the end of four days all six of the seeds in ordinary water gave well-developed seedlings, while those in the heavier water all showed about the same degree of sprouting as occurs in ordinary water in two days. Whether the seeds will continue to develop in water containing 50% of H^2 remains to be seen. The present development is shown in Fig. 2. I am greatly indebted to Mr. J. A. Gullberg for making the photographs.

I have long desired to determine the proportions of isotopes in living matter, in order to see whether the extraordinary selective power of living organisms, which is exemplified by their behavior toward optical isomers, might lead to a segregation of isotopes in some of the substances which are necessary to growth. The marked biochemical differences between the two isotopes of hydrogen lends a further incentive to this search.

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RECEIVED JULY 22, 1933 PUBLISHED AUGUST 5, 1933

THE MOBILITY OF IONS IN H^2H^2O

Sir:

We have compared the conductivity of hydrogen and potassium chlorides in ordinary water and in nearly pure H^2H^2O. Since only about 0.3