DEATH RATE OF WATER BACTERIA.

INFORMATION pertaining to the destruction of bacteria in drinking water and in polluted rivers and streams has come to be regarded as being an important necessity in every community. This, largely for the reason that the knowledge of the danger of pathogenic bacteria to the health of water-users has become widespread.

There enters into the investigation of the degree of pollution and the danger resulting therefrom, the question of the longevity of B. coli. This is necessary in determining the length of time a sample of water may be kept prior to analysis. It is also useful in a determination of the volume to be used in such analysis.

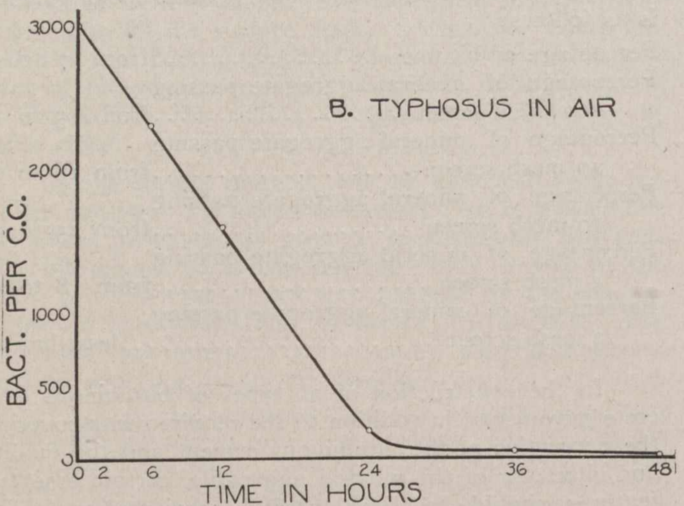

Fig. 1.—Death of B. Typhosus in Air.

In a paper recently prepared by Dr. Otto Rahn, assistant professor of bacteriology, University of Illinois, and Mr. M. E. Hinds, assistant chemist of Illinois State Water Survey, the results are given of experiments made to determine the rate, manner and factors influencing the death of bacteria in drinking water and polluted streams. This paper was presented at a meeting of the Illinois Water Supply Association. From it the following information is secured:

As a number of uncertain factors would be involved in working with a natural water or sewage, it was thought best to work first on pure water under known conditions and to vary the conditions until they finally approached those found in natural waters. The water used for this work was ammonia free, which, however, contained a very small amount of nitrogen. It is purer than ordinary distilled water, being redistilled twice, and is the purest grade of water obtainable unless a large amount of labor is spent on its preparation.

Table I.—Theoretical Number of Cells Present at End of 60 Hours and for Each 6-Hour Interval.

Hours.	Theoretical number of cells.	Actual number of cells.
0	1,000,000	315,000
6	100,000	40,000
12	10,000	937
18	1,000	—
24	100	Less than 1
30	10	
36	1	
42	.1	
48	.01	
54	.001	
60	.0001	

The rate of death of B. typhosus as found by different observers is variable, probably due to different experimental conditions. Of the many contradictory statements concerning the death rate, it is difficult to determine which one is correct as most of the data appear to be reliable. This leaves us in doubt as to whether death is due to lack of food, presence or absence of oxygen, temperature changes or antagonism of other bacteria.

During the last seven years we have learned that bacteria under unfavorable conditions die gradually. Of the total number, a certain percentage will die in a unit of time and of the number surviving the same percentage will die in the next unit of time. As far as we know, this law holds true with all causes of death, whether by disinfectants, light, drying or heat. We know of no exception.

It was only natural to expect this same regularity of death to hold true in the case of B. typhosus and B. coli in pure water. The experiments showed this to be the case. The reduction in the case of B. typhosus was 89.3 per cent. in six hours, that is, after six hours' time only about 10 per cent. of the original number survived. Assuming 1,000,000 cells to be present in the beginning, we find the numbers remaining as shown in Table I., which is based on a reduction of 90 per cent. in each six-hour period.

It is easily seen that we never come to an absolute zero. There are always some bacteria left alive, but the number soon becomes so small, that for practical purposes, we might consider them absent. Table I. shows a reduction in 60 hours from 1,000,000 per c.c. to less than 1 per gallon. Whether such water would be considered safe for use, is questionable. In 96 hours, we would have less than one typhoid bacterium per 1,000,000 gals. Such water would probably be safe. Certainly, no bacteriological or other analysis could discover the bacterium.

B. coli does not die quite as fast as B. typhosus, about 72 hours being necessary to reduce their number from 1,000,000 per c.c. to 1 per gal. Kruse states that B. coli is found a normal inhabitant of all waters, whether good or bad. We can find it, if we only take a large enough sample.

Knowing the facts, we tried to find the cause of death. It is probable that the death of B. coli and B. typhosus in pure water is due to starvation. A sample of tap water was sterilized and inoculated with B. coli and proved to be a fair medium for growth. An initial number of 1,500,000 increased slowly to 3,000,000 in twelve days and then slowly decreased, over half the original number being still present at the end of five weeks, when the experiment was discontinued. At the same time a sample of deep well water with a very high mineral residue was sterilized and inoculated with about 2,000,000 B. coli per c.c. and only 1 per c.c. was found at the end of two days. This death rate was higher than in very pure water. Only a trace of organic nitrogen was present.

It is very important from a practical viewpoint to decide whether or not dissolved oxygen plays any part in the rate of the death of bacteria in water. Whipple and Mayer found B. typhosus died about 20 times as fast without oxygen as with it, and B. coli died about twice as fast. The absence of oxygen was secured by keeping the tubes in an atmosphere of nitrogen and hydrogen. This would suggest a suffocation of bacteria. In our work we have been unable to get the same results with B. coli, as in all of our tests the death rate was lower with-