

a plan of Federal health work acceptable to this Conference. The address by Assistant Surgeon-General McLaughlin will supplement the address by Doctor Goodnow and would assist a steering committee in arranging for a proper relation between Federal and state health activities. The address by Doctor

Farrand, president of the American Red Cross, will bring out the mutual interest existing between the American Red Cross and the official health agencies of the country, and indicate the general principles of coöperation by which the two agencies may assist each other in their closely related fields of service.



THE PRESENCE OF FECAL AND NON-FECAL TYPES OF THE COLON BACILLUS IN VARIOUS TYPES OF WATER.

WILLIAM ROYAL STOKES, M. D., Sc. D.,

Bureau of Bacteriology, State and City Boards of Health, Baltimore, Md.

An investigation of the origin of members of the colon-aërogenes group. "High ratio" aërogenes come probably from grains or cereals, while "low ratio" colon betoken probable human contamination.

SINCE the work of Theobald Smith (1) in 1893 on the detection of the colon bacillus in water by means of the fermentation tube, the isolation of this organism in drinking water has been used as an important guide for the sanitarian. The work of Rogers, Clark, Lubs, Levine, Winslow, Klinger and others has recently demonstrated that the original *B. coli* can now be separated into two groups, namely, the *B. coli* and the *B. aërogenes* group. The *B. coli* type gives a low carbon-dioxide ratio, a positive methyl red test for acidulation, and a negative Voges-Proskauer reaction, while the *B. aërogenes* type shows a high carbon-dioxide ratio, a negative methyl red test, and a positive Voges-Proskauer reaction. The former type is more frequent in the feces of man and many animals, and the latter is much more abundant on grains and cereals.

Winslow and Cohen (2) have collected the results of the various authors who have described the relative proportion of these two types in feces, sewage, raw, stored, and filtered water, grains, and soil, and they show that the low and high

ratio types were present in the following percentages in these various materials:

In the feces of men, horses, cows and other animals a low ratio type was present in 92 per cent of cases and a high ratio type in 8 per cent of cases. In sewage a low ratio type was found in 77 per cent and a high ratio type in 23 per cent. In raw water a low ratio type was found in 75 per cent and a high ratio type in 25 per cent of cases. In stored water a low ratio type was found in 95 per cent and a high ratio type in 5 per cent of cases. In filtered water the low ratio type was found in 97 per cent of cases and the high ratio type in 3 per cent of instances. On grains the low ratio type was found in 9 per cent of cases and the high ratio type in 91 per cent of cases, and from soil the low ratio type was found in 28 per cent of cases and the high ratio type in 72 per cent of cases. The presence of a high percentage of the high ratio type in sewage and raw water can be accounted for by the fact that the washings from grain and soil are often swept into the water of a river as well as the washings from the feces of

men and animals, but it is difficult to account for the very low percentage of a high ratio type of organisms in stored and filtered waters.

The above mentioned observers have also made an investigation "to add to the scanty evidence in regard to the relative prevalence of the *B. coli*, and the *B. aërogenes* types in waters of known sanitary quality in order to throw light on the significance to be attached to their presence.

Their samples were collected from sources known to be polluted, sources unpolluted beyond a reasonable doubt, and samples of stored raw water used for municipal supplies, and of high sanitary quality. In a study of two hundred and fifty-five strains isolated from these sources they came to the conclusion that there was no connection between the type of organisms and the corresponding source.

Since they state that "the final proof or disproof of any such connection must come from extended study in as many different parts of the country as possible," I have thought it worth while to describe some observations made in Baltimore, and other parts of Maryland.

The Baltimore water supply is obtained from a rather small river running through a densely populated adjacent county, and this river is subjected to many pollution; from farms, villages and small towns. The water, however, is impounded by a large dam and then subjected to sedimentation by coagulation, filtration, and final chlorination.

During the present year we have made type determinations on one hundred and sixty-one specimens of lactose fermenting organisms, and the following table will show the result of these determinations. This table is based upon the group reactions in *Standard Methods of Water Analysis*, A. P. H. A., 1907, page 108. We were

unable to differentiate between the *B. aërogenes* of fecal and non-fecal origin since we were unable to obtain any adonite. The unknown organisms mentioned did not absolutely conform to any of the groups described in *Standard Methods*.

The results of our type determinations, however, can be broadly grouped into three classes, namely, the low ratio colon group, the high ratio aërogenes group, and the gelatin liquefying cloacæ group. The unknown types under these three subdivisions were methyl red positive gelatin negative, methyl red negative gelatin negative and methyl red negative gelatin positive, positive meaning the liquefaction of gelatin. We, therefore, found low ratio methyl red positive organisms in 51 per cent of cases, high ratio methyl red negative in 16.7 per cent of cases and high ratio methyl red negative but gelatin liquefying organisms in 28.6 per cent of instances. These groups correspond respectively to the colon type, the aërogenes type and the cloacæ type.

TABLE SHOWING TYPES ISOLATED FROM FILTERED BALTIMORE WATER.

Colon, fecal type.....	83 or 51.5%
Colon, unknown type.....	5 or 3.1%
Aërogenes, fecal type.....	5 or 3.1%
Aërogenes, unknown type.....	22 or 13.6%
Cloacæ type.....	23 or 14.3%
Unknown type.....	23 or 14.3%

Total.....161

An attempt has also been made to ascertain as far as possible the various sources of low ratio, high ratio, and gas-producing, gelatin liquefying *B. cloacæ* organisms in drinking water from various sources throughout the state of Maryland, including chlorine treated and untreated water, raw and filtered waters, spring water and well water. Specimens from milk, oysters, sewage, human and bovine feces and urine, cereals and grains were also examined, and the results are expressed in the following table:

TABLE I.

SOURCES AND RELATIVE FREQUENCY OF THE THREE TYPES OF ORGANISMS FOUND IN A STUDY OF 1,145 CULTURES FROM EIGHTEEN DIFFERENT SOURCES.

Source.	No. of sam- ples	No. of cul- tures	High ratio	Low ratio	B. cloacæ
Water.....	444	528	294	192	42
Milk.....	271	271	129	109	33
Oysters.....	54	54	23	26	5
Sewage.....	23	31	12	18	1
Stools, human	11	141	0	118	23
Stools, bovine.	1	15	2	13	0
Urines, human	2	28	1	24	3
Corn meal....	1	0	0	0	0
Grape nuts...	1	0	0	0	0
Post toasties..	1	0	0	0	0
Corn flakes...	1	7	3	4	0
Puffed wheat.	1	0	0	0	0
Quaker oats..	1	15	3	11	1
Rye.....	2	17	15	2	0
Corn.....	2	18	18	0	0
Wheat.....	1	6	1	2	3
Barley.....	1	8	8	0	0
Oats.....	1	6	5	1	0

As will be seen in Table I, more than half, or 55.6 per cent, of the members of the colon-aërogenes group isolated from water belonged to the high ratio group; 43.9 per cent of this group were obtained from the cultures isolated from milk, and 42.5 per cent from oysters. In sewage the high ratio group was present in 38.7 per cent; in feces (human and bovine) and urines in only 1.6 per cent; in cereals in 26.18 per cent and in the various grains in 85.4 per cent. It is interesting to note that there were no high ratio organisms in the one hundred and forty-one cultures obtained from human stools.

Table II shows the relative proportion of the three groups of organisms in raw, filtered and chlorine treated waters obtained from one hundred and twenty-two wells, twenty-seven springs, and the public water supplies of eleven towns in Maryland. There is nothing striking in this table excepting that it shows that filtered and treated waters contain a

somewhat higher percentage of low ratio organisms than raw water. Of greater interest is the fact only one low ratio organism was found in fourteen samples of water from artesian wells containing members of the colon-aërogenes group. Twelve of the samples contained high ratio organisms and one the *B. cloacæ* type.

TABLE II.

	High ratio	Low ratio	B. cloacæ
Raw waters.....	116	62	5
Filtered waters.....	12	38	3
Waters treated with chlorine or hypochlorite.....	60	60	6

Rogers (3) has shown that the *B. aërogenes* is more resistant than the *B. coli*, and that its percentage as compared to that of *B. coli* gradually increased during long storage. This same percentage increases in polluted water as the specimens are obtained further and further from the source of pollution, and the preponderance of *B. aërogenes* over *B. coli*, or an opposite condition might be considered an indication of immediate or remote pollution.

In the routine examination of drinking water, a specimen is frequently met with which contains colon bacilli, as tested by the present Standard Methods of Water Analysis, but which on chemical examination shows no evidence of intestinal pollution, and a sanitary survey of its source shows no reasonable cause to suspect fecal contamination. In the studies already cited it was found that more than 50 per cent of the colon-aërogenes group isolated from water belonged to the high ratio type, and it was to determine whether or not it would be practical to consider waters containing this type as free from pollution that the following tests were made.

Ten colonies from Endo plates were fished from each of 59 samples of raw water and 38 samples contained but one

type of organism; 24 of these contained only high ratio organisms; 13 contained only low ratio types, and the *B. cloacæ* type was found in one. Plates from the 21 remaining samples contained two or more types of these bacteria, *i.e.*, each sample contained both high ratio and low ratio types, with an occasional *B. cloacæ*.

Dr. H. W. Stoner, who made these tests of state waters, had intended to compare the results with the sanitary survey made in connection with each sample, but his untimely death interrupted this part of the investigation. It is significant, however, that a larger percentage of wells and springs contain a preponderance of either low or high ratio groups, while a smaller number contain a mixture of both groups. It would have been interesting to have known whether the sanitary survey showed pollution from human or animal feces in the low ratio and mixed groups, and only soil pollution from the high ratio group. Further work in this matter should be carried out.

SUMMARY AND CONCLUSIONS.

The colon-aërogenes group of bacteria has quite a wide distribution in nature.

A study of the sources of the various types shows that the one known as the high ratio is constantly present on grains, and cereals and only occasionally found in stools and urines. On the other hand, the low ratio type is constantly present in

stools and urines but is rarely found on grains and cereals. The *B. cloacæ* type is less frequently found, and is obtained from both these sources in about equal proportion. It therefore seems that grains may be regarded as the principal source of the high ratio type and stools and urines of the low ratio type.

In the bacteriological examination of drinking water it would not be safe to assume that the water was free from intestinal pollution if but two or three colonies were studied from each specimen. However, if twenty to twenty-five colonies be picked from each sample, and all are found to be of the high ratio type, it might be safe to regard the water as free from fecal contamination provided a chemical examination and sanitary survey gave no evidence of pollution. Of course, the isolation of even one low ratio type from a sample would indicate intestinal contamination. It would be impractical to examine twenty or twenty-five cultures from every sample of water in general routine work where a number of samples are examined, but the method can be applied to special samples and to those that, from a sanitary survey and chemical tests, show no evidence of pollution.

LITERATURE.

1. Wilder Quarter-Century Book, 1893, p. 187.
2. Jour. Infect. Dis., 1918, 23, p. 90.
3. Jour. of Bact., 1918, 3, p. 312.



The National Municipal Review (Philadelphia: National Municipal League) has become a monthly with its May issue. This change has been in response to a widespread demand on account of the increasing importance of the magazine. Its position as the organ of a live association assures to it freedom of expression and an opportunity for advanced and even prophetic thought. It numbers among its contributors the foremost municipal specialists in the country, men interested in the dissemination of good principles in municipal management and men, indeed, who have been foremost in inaugurating the reforms that are directed at honest and efficient city government.

English Birth and Death Rates.—During the last quarter of 1918, the death rate in England exceeded the birth rate for the first time in the history of civil registration in that country. When the facts became known, the War Office released 700 physicians from the army in one week. The death rate was greatly increased because of the large number of influenza deaths. The number of deaths from this cause was 98,998, or 41 per cent of the total deaths, for the quarter. It is believed that the lack of physicians in controlling the disease materially aided in swelling the number of deaths.—*Boston Medical and Surgical Journal*, May 8, 1919. (M. P. H.)