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CRITERIA FOR MAINTAINING BALANCE OF PROGRAM IN COUNTY HEALTH DEPARTMENTS[1]

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Many years ago Socrates was wont to tell the young men of Athens to define their terms. This injunction, though often neglected, is as good to-day as it was when Socrates lived and taught. A criterion may be defined as a standard by which a correct judgment can be formed. A standard, in turn, is defined as a concrete measure to which everything of the same kind must conform. Thus it is seen that criterion adds to standard the idea of judgment; it implies not so much the idea of conforming to as of meeting a test. This conception of criterion should be borne in mind throughout this discussion.

It will be admitted without argument that any county health department should have a balanced program; and as a corollary to this proposition it may be stated that the smaller the unit, the more necessary the balance. Granting that programs must have balance, the question confronting the health officer is how to secure and maintain this balance. In endeavoring to answer this question the experience in Gibson County will be used to a great extent. It may be that some of the methods used there are not applicable to other counties, but in general it is felt that these methods can be used in any county.

There are four factors which may serve as criteria for maintaining balance of program in county health departments. These are (1) definition of problems, (2) fitting of resources to problems, (3) use of the Appraisal Form, and (4) planned-work programs.

In defining problems confronting the health department, the communicable-disease problem holds first place. The primary function of a health department, the primary reason for its establishment and inclusion in the body politic, was and is the control of communicable disease. It is true that the scope of health work has widened, and rightly so; but this does not alter the fact that communicable-disease control is of paramount importance, and this problem should be clearly defined.

In Tennessee, tuberculosis is a major problem in every county. This problem can be brought more clearly into focus in a variety of

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ways. One of the best methods is by the tuberculin testing of school children. By following up the positive reactors a great deal of hitherto unknown tuberculosis can be found. With a limited personnel and a large school population it will be impossible to follow up all the reactors in any one year, but an effort should be made to test and follow up as many as possible. This procedure will serve several purposes. It will more clearly define the problem, it will serve as ammunition in securing increased local appropriations, and it is a means of educating and interesting the general public.

Another method for defining the tuberculosis problem is the use of the case-finding clinical service offered by the State department of public health. This activity should be integrated with the tuberculin-testing activities; that is, the leads developed by the tuberculin testing should be followed up, in so far as possible, by examination in the tuberculosis clinics.

Although these methods are more or less familiar to every health worker, it must be remembered that if the problem is going to be attacked efficiently it must be clearly focused, and tuberculosis looms large as a problem in communicable disease control.

Typhoid, diphtheria, and other communicable diseases should be attacked in the same way. The morbidity and mortality rates for several preceding years should be known, as well as the location of the cases and the age groups affected. It was by surveys and by studies of morbidity and mortality rates that the problem of diphtheria control was accurately defined. As a result of that work every health officer knows that diphtheria control should be directed to the preschool group.

Some communicable diseases are of such a nature that it is extremely difficult to get even an approximate idea of their prevalence. An example of this is venereal disease. Although knowledge is not complete, there is sufficient data to justify the statement that there is no other group of diseases so widespread and so devastating in their effects, not only on the present generation but on future generations. Thus, in the area of the United States in which syphilis has been reported since 1920, there have been 35,000 more cases of syphilis reported than of scarlet fever; 79,000 more than all forms of tuberculosis; 500,000, or nearly one-third, more cases of syphilis than of diphtheria; three times as much syphilis as smallpox; and five times as much syphilis as typhoid fever.

By examination of food handlers, by Wassermann tests on all people examined in the health department, and by securing the active cooperation of practicing physicians, an appalling number of cases of syphilis will be found in every county. If any health officer says that syphilis is not a problem in his county, it means that he has not looked for it. Most illuminating data can be uncovered if every case that is found is followed up by an examination of other members of the family. Thus, in a group of 276 patients in active attendance at the clinics in Gibson County there were 168 primary examinees. By this is meant that there were 168 patients in this group who first came to the clinic. Of these 168 primary examinees, 92 were married. Of these 92, there were 77, or 86.6 per cent, who had contacts examined. There was a total of 108 contacts examined, or 1.4 per person.

What is true of communicable diseases is true of other problems. In child hygiene the health officer should have an accurate knowledge of maternal and infant deaths and the causes thereof. He should, too, know the number and causes of deaths of children under 5 years, and by his school examinations he can learn the quantity and quality of defects in school children. With this knowledge the health officer can better plan his campaign.

In the field of sanitation an accurate knowledge of conditions is fundamental to a program of control. The number and physical condition of food and milk handlers must be known, and the condition of private and municipal water supplies—in short the sanitary status of the county—must be determined before planning a program in sanitation.

The second criterion is the fitting of resources to problems. It is useless to hunt elephants with a sling shot. The major effort should be spent on major problems. For instance, a program of stocking ponds with top minnows in a county where there is no malaria would be wasted effort. The point is simply this: If malaria is your chief problem, then that problem should be attacked first. No one should advocate taking one problem and trying to solve it at the expense of every other activity; nor should one spread his efforts over so many activities that he accomplishes nothing. The larger part of one's time and effort should be spent on major problems, and other activities should be subordinated.

Such a plan is not always completely workable. Public opinion may demand certain activities that the health officer must perform in order to retain the public support. In this regard it should be remembered that there is a twofold object in health work: One is to do the health work proper, and the other is to carry out any legitimate project that will aid is selling the work to the people of the county. Sometimes this latter may be time-consuming, but it is necessary.

In fitting resources to problems, surveys are of inestimable value. These surveys have previously been mentioned with reference to defining problems. There is another benefit which may be derived from surveys, and that is that they aid in bringing the details of public health problems before the public, showing the needs of the community, and will often be the entering wedge for increased appropriations.

The third criterion is the use of the Appraisal Form of the American Public Health Association. It is pretty generally agreed that this form is the best method we have at present for securing a balanced program. Every health officer should take the Appraisal Form and appraise his own unit by the standards set forth there. It will do more to show the lack of balance in his program than almost any other method. In view of its importance it should be discussed in some detail. At the outset it should be remembered that it is not an appraisal of the health unit but of the community's health assets. For example, if two units, A and B, are doing exactly the same quantity and quality of work, and B's community has twice the population, then the appraisal of A's unit will be higher than B's, because indices are based largely on population. It should also be remembered that the score is not the essential thing but that the form should be used to show the ratio of activity or accomplishment to what group judgment states as desirable.

The record system in Tennessee is built around the Appraisal Form. This form takes up in detail vital statistics, communicable-disease control, venereal-disease control, tuberculosis control, child hygiene, sanitation, laboratory work, and public-health education. It is essentially a program of activities and services rendered. In order to have a balanced program, each of the above items must be considered.

Section A gives 60 points out of a thousand to vital statistics. To meet the requirements of this section, careful record keeping is essential. Regardless of size, any unit should get a high score on this item.

Careful record keeping is also an essential in section B, which deals with communicable-disease control and to which 175 points are allotted. A small unit can not possibly score extremely high on this item, but it will serve as an excellent criterion for maintaining balance of program if it is followed in so far as facilities permit.

Section C deals with venereal-disease control, and this is one of the most important activities in which a health department can engage, although, due to the scant attention given to it, only 50 points are allotted in the Appraisal Form. Venereal disease is an urgent problem in every county in every State. One should not be discouraged by a small start. In 1925 in Gibson County there were only 11 cases under treatment, and the unit would not have scored more than 2 points out of the possible 50. In 1929 Gibson County scored 38 points, and this with no increase of personnel. The increase in venereal-disease work came as a result of study of the problem of fitting of resources to the problem, and of an attempt to meet standards which the group judgment of the Appraisal Form has set up as necessary.

In order to secure very many points under section D, which is devoted to tuberculosis control, it is almost essential that a county have a fairly adequate force of nurses and some hospital facilities. Surveys in this field are necessary for building up public demand for increased facilities.

Section E is devoted to the health of the child. It starts with the prenatal care and carries the child through school. Prenatal service can be developed to an extremely high degree. Prior to March, 1930, practically no prenatal service was given in Gibson County. In January there were 6 new cases under supervision, in February 4 were added, in March 18, in April 69, in May 61, in June 53, in July 60, in August 21, in September 44, in October 44, and in November 35 were added, making a total of 415 new cases admitted up to December 1. This clearly demonstrates how one might have present in his county an unrecognized potentiality, easily made actual by a little change in emphasis, presentation, or perspective.

The Appraisal Form gives what group judgment deems desirable in the field of child health. It is a distinct aid in forming a judgment of one's work—in short, it answers the requirements for a criterion.

In looking over the quota of nursing visits in the field of communicable disease, tuberculosis, prenatal cases, infants, and school children, one's tendency is to be discouraged. But with the use of the family folder it is surprising how many visits one nurse can make. For example, she may go to visit a prenatal case, and in the same home there are two preschool children and two school children. And so at this one visit she may take up each child and get credit for a prenatal visit, two preschool visits, and two school visits. In many instances tuberculosis cases will have preschool or school children in the home. It is certain that by correct use of the family folder and careful record keeping a great many visits can be made, and, conversely, one can fail to make a good showing by the lack of a careful record of work done.

Section F deals with sanitation. It accounts for improvement of water supply, of excreta disposal, and of milk control. At this point the importance of physical examination of food handlers should be stressed. Until 1930 Gibson County never gave the subject much consideration, but during the past few months regular hours have been scheduled for the examination of food handlers. Up to November 15, 236 food handlers were examined—187 white and 49 colored. Of the 187 white persons, 2.6 per cent showed a positive Wassermann and 3.7 per cent showed a positive diphtheria culture. Among the 49 negroes, 16 per cent were found with positive Wassermann and 4 per cent with positive diphtheria cultures. All had negative stool and urine cultures for typhoid.

Section G takes up laboratory work and popular health education.

The fourth criterion is the use of a planned work program. Any health officer will find that his performance will increase in amount and efficiency when he follows a charted course. In Gibson County an attempt is made to chart a course each month. A proper schedule allows plenty of latitude for other work that might come up unexpectedly. What the schedule aims at is to accomplish certain definite things at certain definite times during the month. Such a plan will do away with a great deal of haphazard work. Without some such plan it is certain that a great deal of time and effort will be wasted.

Thus, a definition of public-health problems, a fitting of all available resources to these problems, the proper use of the Appraisal Form, and a planned work program built around these criteria will aid in working out a balanced program. In order to check up on the shaping of the program, the performance sheet is essential. It will aid the health officer in visualizing the progress of his program.

SUMMARY

A criterion implies the idea of meeting a test, and to meet the tests adequately balanced programs are essential. There are at least four criteria for maintaining balance of program, viz, the definition of problems, the fitting of resources to problems, the use of the Appraisal Form, and planned-work programs. The problems should be determined and the resources at hand fitted to these problems. The Appraisal Form will aid in distributing efforts to give attention to vital statistics, communicable-disease control, tuberculosis and venereal disease, prenatal, infant, preschool, and school hygiene, the problems of excreta disposal, pure milk and water supply, the physical condition of food handlers, laboratory work, and popular health education. Finally, a planned work program will aid in carrying out the proposed program.

EXPERIMENTAL STUDIES OF NATURAL PURIFICATION IN POLLUTED WATERS

V. THE SELECTION OF DILUTION WATERS FOR USE IN OXYGEN DEMAND TESTS

By EMERY J. THERIAULT, *Chemist*, PAUL D. MCNAMEE, *Technical Assistant*, and CHESTER T. BUTTERFIELD, *Bacteriologist, United States Public Health Service*

Despite the numerous difficulties which surround the application of biochemical oxygen demand tests to the estimation of the "strength" of raw sewages, the "quality" of sewage effluents, or the "stability" of polluted waters, it is significant that, even in their present stage of development, the use of such tests has become widespread. While the improvement of these biochemical procedures has been primarily of analytical import, no other class of sanitary chemical tests has proved more fruitful in the formulation of a rational theory of biological oxygenations as exemplified on a practical scale in modern sewage treatment.

At the present time the interest of several groups of workers has been centered on an attempt to effect a further degree of standardization in analytical procedures for the determination of the oxygen demand of polluted waters. In particular, considerable interest has been manifested in the production of a "standard" dilution water for use in such tests.[1]

In the present study of the effect of mineral salts on the rate and extent of biological oxygenations, the primary interest, therefore, has been to contribute toward the selection of a dilution water for general use in oxygen demand tests. In another direction, the effect of mineral salts is of considerable importance in investigations of self-purification in highly mineralized tidal waters and in waters heavily charged with industrial wastes of mineral origin. These studies also have a bearing on the question in sewage treatment regarding the relative effect of "hard" and "soft" waters as carriers of pollution.

Recommendations in the 1925 edition of Standard Methods of Water Analysis of the American Public Health Association are to the general effect that, for use in oxygen demand tests, a dilution water should be free from iron and should not contain more than 0.01 part per million of nitrogen as nitrate, nitrite, or free ammonia. The stipulation in regard to the allowable nitrogen content is so severe that, as pointed out by Mohlman, Edwards, and Swope (1928), "Few tap waters could meet these specifications and the inference is that distilled water would be suitable provided it is low in ammonia." Other recommendations regarding the selection of a suitable dilution water for use in oxygen demand tests have ranged from the advocacy by Theriault and Hommon (1918) of stored tap water to the proposal by Garner (1922) of "ammonia-free distilled water, prepared by distillation from acidified water."

More recently various synthetic waters have been proposed to simulate in greater or less degree the mineral salt content of natural waters. The composition and properties of these dilution waters

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[1] The boards of engineers of the Great Lakes Drainage Basin and of the Ohio River have appointed a joint committee to formulate plans for cooperative research The personnel of this committee is as follows:

Indiana: E. H. Parks.
Michigan: W. S. Sperry.
Minnesota: H. A. Whittaker.
New York: C. R. Cox.
Ohio: R. D. Scott.
Pennsylvania: F. E. Daniels.
Wisconsin: F. L. Warrick, *Chairman*.
United States Public Health Service: E. J. Theriault.

Extensive studies have been carried out by the Sanitary District of Chicago (F. W. Mohlman). The problem has also been considered by the Illinois State Water Survey (A. M. Buswell) and by the New Jersey State Department of Health (L. Forman).

will be briefly described in the following pages. It will next be shown that, in all probability, the specifications for a dilution water suitable for use in studies of nitrification as in sewage effluents (or in prolonged observations on the oxidation of raw sewage) would be far more rigid than in similar studies of the first or carbonaceous stage of deoxygenation. Limiting the discussion to the simpler case, numerous experiments will then be presented to show the effect of various mineral salts in different concentrations and at different pH values on the course and extent of the deoxygenation of raw sewage. It is believed that only with the accumulation of similar data by other interested organizations, working with other wastes, can further progress be made in the desired standardization of the oxygen demand test.

SYNTHETIC RIVER WATERS (FORMULA A)

In preliminary experiments on the effect of mineral salts on the deoxygenation of polluted waters, use was made of a dilution water which, on the basis of data kindly furnished by Dr. W. D. Collins, United States Geological Survey, is believed to be fairly representative of the average American river water, excluding certain western waters. The composition and method of preparation of this synthetic river water is given in Table 1. With the omission of silicates and of the trace of nitrates and manganese, this water corresponds very closely to a synthetic river water (Formula A) which we have used as an approximation to the "average" composition of Ohio River water at Cincinnati, Ohio.

TABLE 1.—*Composition of the "average" American river water*

Constituent	Composition		Chemical used	Milligrams of salt per liter
	Parts per million	Per cent		
Ca	36	21.1	CaO	50.40
CO_3	54	31.6	CO_2	39.60
Mg	10	5.8	$MgSO_4$	50.00
SO_4	40	23.4		
Na	10	5.8	NaCl	7.91
Cl	5	2.9	Na_2SiO_3	18.32
SiO_3	12.8	7.5	K_2SiO_3	2.71
K	2	1.2	KNO_3	1.63
NO_3	1	.6	$FeCl_3$	.30
Fe	.1	.1		
Mn	.01	Trace.	$MnSO_4$	.03
Total [1]	170.9	100.0		170.9

[1] Basis of solids at 180° C.

The theory in the use of this synthetic river water was that the ideal dilution water for stream pollution studies should be one in which the mineral constituents were approximately the same as those naturally present in the receiving body of water. The advantage in the use of such a dilution water lies in the avoidance of troublesome corrections for organic matters generally present in river waters. This condition was fulfilled by Theriault and Hommon (1918) through the use of stored tap water (filtered river water) in studies of the Ohio River. A similar opinion is expressed in the recommendation of Cooper, Cooper, and Heward (1919) that the dilution water should be taken from the stream into which effluents are to be discharged.

FORMULAS B AND C DILUTION WATERS

It is obvious that, under ordinary field conditions, the more or less exact duplication of the mineral salt content of a given receiving body of water would frequently be impracticable. In simplification of Formula A, calcium chloride was accordingly substituted for calcium bicarbonate which had been prepared by passing carbon dioxide through a suspension of calcium hydroxide. The buffer strength of this modified dilution water (Formula B) is very low. In experiments designed to test its suitability for dilution purposes it was therefore considered advisable to buffer the solution by the addition of phosphates. As an abundant supply of sodium and potassium was thereby introduced, these ingredients were accordingly omitted from the original formula. The simplified solution, denoted as Formula C, then possessed the composition given in Table 2.

TABLE 2.—*Composition of Formula C dilution water*

Constituent	Milligrams per liter			Stock solutions of mineral salts	Grams of salt per liter of stock solution	Milliliters of stock solution per liter of dilution water		
	Quarter strength	Half strength	Full strength			Quarter strength	Half strength	Full strength
Ca	10.0	20.0	40.1	0.10 M $CaCl_2 \cdot 4H_2O$	18.3	2.5	5	10
Cl	17.7	35.4	70.9	do				
Mg	2.4	4.9	9.7	0.004 M $MgSO_4 \cdot 7H_2O$	9.9	2.5	5	10
SO_4	9.6	19.2	38.4	do				
Fe	0.01	0.03	0.06	0.001 M $FeCl_3 \cdot 6H_2O$	0.27	0.5	1	2
Total [1]	39.7	79.5	159.2					
KH_2PO_4, $KNaHPO_4$	47.4	94.7	189.4	Phosphate buffer	[2]	1.25	2.5	5
Total [3]	87.1	174.2	348.6					

[1] Exclusive of buffer salts.
[2] See text.
[3] Inclusive of buffer salts. For the calculation it was assumed that the constituents of the buffer solution are KH_2PO_4 and $KNaHPO_4$.

It will be noted that the total mineralization, inclusive of buffer salts, for the solutions denoted in Table 2 as "quarter strength," "half strength," and "full strength" is, respectively, 87, 174, and 348 parts per million. In respect to mineral-salt content these solutions may be regarded as roughly representative of soft, average, and hard waters.

"PHOSPHATE" DILUTION WATER

The phosphate buffer solution specified in Table 2 is the Clark-Lubs KH_2PO_4–NaOH mixture. As the pH value of most natural waters is comprised in the range 6.4 to 8.0, an average figure of 7.2 was selected as a standard of reference. Numerous experiments were also made at other pH values.

The buffer solution is readily prepared by dissolving 34 grams of KH_2PO_4 in about 500 milliliters of distilled water. A solution of sodium hydroxide (40 grams of NaOH per liter, corresponding to 1 M) is then added until a pH value of 7.2 is reached and the solution is made up to 1 liter. Approximately 175 milliliters of 1 M NaOH are required. In comparative tests the arbitrarily selected value of pH 7.2 may be shifted by varying the amount of hydroxide added to the potassium acid phosphate. The hydroxide solution need not be accurately standardized and, with sufficient accuracy, the adjustment of the pH value can be made with color standards or color charts.

Use has been made of this phosphate solution either singly or in combination with other mineral ingredients. (Formula C.)

Apart from their usefulness as buffering agents, it is recognized that phosphates constitute a considerable proportion of the mineral content of bacterial ash, and so, together with traces of iron and other salts, they are presumably to be considered as essential nutrients. Although seldom reported in examinations of water, it is nevertheless true that polluted waters must contain at least traces of phosphates derived from sewage. Cooper and Read found from 0.20 to 0.76 part of phosphate (expressed as phosphorus) per 100,000 parts of sewage effluents. The corresponding figures in terms of KH_2PO_4 are from 9 to 33 parts per million. Froehde (1930) reports 0.55 grams per gallon of P_2O_5 in a sewage effluent, corresponding to 18 parts per million as KH_2PO_4. In work with sewage effluents it appears that phosphates should constitute an important fraction of the total mineralization although, even at a moderate dilution, the phosphate content of a polluted-river water should be very small. Pearsall (1930) gives figures indicating that the phosphate content of a "very clean" stream varies from 0.01 to 0.06 part per million when expressed as KH_2PO_4. Greaves and Hirst (1919) report the presence of from 0.72 to 5.47 parts per million of phosphorus (3.2 to 24.0 parts per million as KH_2PO_4) in 10 of the largest streams in Utah. Such analyses, however, are seldom made and, in the absence of reasonably complete data for representative eastern and middle-western waters, no mention of phosphorus was made in Table 1.

It is evident that, in many respects, the composition of Formula C water is purely arbitrary. It does, however, furnish a readily prepared solution whose mineral salt content and pH value may both be varied over a wide range. For this reason it has appeared desirable to use such a solution in exploratory experiments designed to test the influence of these factors on the deoxygenation process. It is recognized, however, that several other formulas have been proposed which, on the score of simplicity of preparation, deserve careful consideration in a study of this character.

"BICARBONATE" DILUTION WATERS

Mohlman, Edwards, and Swope (1928) have proposed the use of a dilution water containing 500 parts per million of sodium bicarbonate as the single ingredient. "It may not be the ideal type of water because of the high pH and the lack of variety of cations, but it is an improvement on distilled water or tap waters of widely varying composition." Later (private communication) it was found possible to reduce the bicarbonate content to 300 parts per million.

The keeping properties of a bicarbonate solution when stored at laboratory temperatures are shown in Table 3. In the first experiment a solution containing 300 parts per million of $NaHCO_3$ was stored in a partly filled carboy protected from the air only by a cotton plug. The pH value ranged from 7.8 at the start to 8.3 or 8.4 after two or three weeks of standing. In a second experiment the bicarbonate solution was stored in a tightly stoppered bottle. Under these conditions the pH value did not change. In a third experiment, using cotton-plugged carboys, the pH values at the start with 75, 150, 300, and 500 parts per million of $NaHCO_3$ were 7.5, 7.7, 7.8, and 8.0 respectively. After three weeks at laboratory temperatures, the corresponding pH values had increased to 7.8, 8.0, 8.4, and 8.6. These values are in practical agreement with the known equilibrium values for bicarbonate solutions. (*Cf.* Prideaux, 1917, pp. 205 et seq.)

TABLE 3.—*Effect of aging on pH value of bicarbonate dilution water*

$NaHCO_3$ content, parts per million	Period of storage, in days										
	0	1	2	3	4	6	14	16	22	25	35
	pH values—First experiment										
300	7.8	7.8	8.0	8.2	8.0	8.2	------	8.3	------	8.4	8.3
	pH values—Second experiment										
300	7.8	7.8	------	7.8	------	7.9	------	------	------	------	------
	pH values—Third experiment										
75	7.5	7.6	------	------	7.7	7.7	7.7	------	7.8	------	------
150	7.7	7.7	------	------	7.8	7.8	7.9	------	8.0	------	------
300	7.8	7.9	------	------	8.1	8.1	8.3	------	8.4	------	------
500	8.0	8.1	------	------	8.3	8.4	8.6	------	8.6	------	------

The conclusions to be drawn regarding the keeping qualities of the bicarbonate solution are obvious enough. It is perhaps of more consequence that the bicarbonate itself, if exposed to air, may contain a considerable proportion of carbonate.

As a variant of the sodium bicarbonate solution used by Mohlman and his associates, a few tests have also been made with the potassium bicarbonate solution proposed by Forman (1928). Tests have also been made with mixtures of phosphates and carbonates.

Greenfield, Elder, and McMurray (1926) have made use of a dilution water consisting of distilled water to which was added $CaCl_2$ (165 parts per million), KCl (10 parts per million), $MgSO_4 \cdot 7H_2O$ (285 parts per million) and $NaHCO_3$ (336 parts per million). The bicarbonate content of this mineral water is about the same as that recommended by Mohlman (300 parts per million). The total mineralization, on the basis of solids at 180° C., is 516 parts per million. A well-defined nitrification stage was observed when dilution was accomplished with this water. This dilution water bears the same relation to the simpler formula of Mohlman that Formula C water bears to the phosphate solution.

DISCUSSION

In connection with the use of bicarbonate solutions for dilution purposes in oxygen demand tests, the following statements by Waksman (1927) are of interest:

1. "The optimum reaction for the respiration of nitrite-forming organisms was found to be at pH 8.4 to 8.8, with limiting reactions at pH 7.6 and 9.3. The optimum reaction for the respiration of nitrate-forming bacteria was found to be at pH 8.3 to 9.3, and the limits at pH 5.6 and 10.3. The presence of $NaHCO_3$, which acts as a buffer at pH 8.4, is, therefore, beneficial to the activities of these organisms." (*Loc. cit.*, p. 528; see also pp. 392 and 77.)

2. Elsewhere (*loc. cit.*, p. 535): "In view of the fact that CO_2 is used by the (nitrate-forming) organism for the building up of its cells chemosynthetically, its presence is necessary for growth. But since the organism produces only a limited amount of growth, only small amounts of CO_2 are required even for the maximum nitrification. Larger amounts seem to act merely as an inert gas." On page 525: "Nitrites are formed also in an atmosphere free from CO_2 (but containing CO_2 in the medium), although at a slower rate."

3. Again (*loc. cit.*, p. 392): "When phosphates were used as buffering agents the (nitrifying) organism was found to make a normal growth, using the CO_2 coming into solution from the atmosphere. No growth took place in the total absence of CO_2."

It will be noted that the pH values which appear most favorable to nitrification by soil bacteria are much higher than those ordinarily observed in streams and also in sewage treatment where active nitrification does occur at pH values which in certain cases may be well below 6.0. In fact, Waksman (1928, p. 529) points out that by gradual adaptation (or perhaps by selective culture) the nitrifying organisms can be made to grow at pH values far removed from the usual range of growth of ordinary soil bacteria. Gaarder and Hagem (1922–23) distinguish various nitrifying organisms with respective optima at pH values ranging from 7.9 to 6.5, and Cutler (1930), in work with sugar beet wastes, has extended these values to pH 4.5.

As regards the desirability of providing traces of carbon dioxide for the growth of nitrifying organisms, it is obvious that an ample supply of this constituent will be present when the bicarbonate dilution waters are used. Even with Formula C water, however, it has appeared that a sufficient supply of CO_2 will be assured through the addition of the sample itself with sewage effluents at moderate dilutions or by the prior decomposition of carbonaceous materials in tests with raw sewage.

In passing it may be remarked that, according to Bonazzi (1923), "the presence of KOH in a cultural system stops nitrification * * *." This observation has a direct bearing on the Sierp (1928) method in which a seal of NaOH or KOH is used to remove CO_2 from the system. The failure to observe a second or nitrification stage when this apparatus is used may be due to the removal of CO_2, although, as pointed out by Symons and Buswell (1929), other explanations may be offered.

Another cultural characteristic of the nitrifying organisms which is emphasized in the studies of the soil microbiologists is the relatively high dissolved oxygen requirement of these organisms. With particular reference to nitrate formation the following quotations from Waksman (1927, pp. 393 and 534; see also p. 396) are in point: "A decrease in the concentration of oxygen lessens both growth and respiration, so that at one-tenth atmosphere pressure (0.9 parts per million at 20° C.) respiration is decreased by 66 per cent; the optimum concentration of oxygen for nitrate formation was found to be 35 per cent" (about 16 parts per million at 20° C.).

In our own studies definite evidence has been obtained that nitrite formation may cease when the dissolved oxygen content is reduced to about 2 parts per million. The proposal by Johnson (1924) to increase the dissolved oxygen content of incubated samples and his statement that "the adoption of a higher initial saturation is the crux of the whole matter" may find explanation on the basis that his work was done mainly with partly purified sewage effluents of low dissolved oxygen content.

The importance of these growth requirements of the nitrifying organisms is evident enough when it is considered that the presence of these highly specialized organisms is essential to the nitrification process, so that, whether intentioned or not, any study of deoxygenation in polluted waters may become a "pure culture" problem when the observations are extended into the second or nitrification stage. The situation in this respect differs materially from that encountered in similar studies of the first or carbonaceous stage where the deoxygenation process is carried on by mixed cultures adaptable to a wide range of variation in such factors as pH value, carbon dioxide tension, and dissolved oxygen content.

There is a wealth of information in the studies of the bacteriologists regarding the effect of mineral salts on the growth of microorganisms. It is seldom, however, that these studies have been accompanied by observations on the decrease in the dissolved oxygen content of the experimental solutions. In the literature of oxygen demand tests the evidence offered is often contradictory. Thus, it appears reasonably well established that nitrate formation is greatly retarded when samples of polluted water are diluted with sea water. (*Cf.* Theriault, 1927, pp. 9–10 for a review.) This view is supported by the work of Cooper and Cooper (1918), Cooper, Cooper, and Heward (1919), and Purvis (1926), who report that, under ill-defined conditions of test, a more vigorous oxidation may be obtained with distilled water than with mineralized dilution waters. However, as noted by Cooper, Cooper, and Heward (1918), the results are by no means consistent, so that a hard water may exert "either a greater or a smaller inhibitory action than a soft water." Again, in certain cases, "it makes no difference whether distilled or river water is used."' On the other hand, the results obtained by Mohlman (1925), Greenfield, Elder, and McMurray (1926), Mohlman, Edwards, and Swope (1928), and by Symons and Buswell (1929) indicate that the use of distilled water as a diluent should be avoided. It is perhaps significant that, in the main, the favorable results reported with distilled water have been obtained with sewage effluents at moderate dilutions (generally 1 to 5), while the unfavorable results are based on examinations of industrial wastes or raw sewage.

On the basis of the foregoing discussion and of numerous experiments in this laboratory, it has appeared clearly indicated that the effect of mineral salts on the deoxygenation process could not be considered apart from the state of oxidation of the samples. In the present paper a considerable simplification in the presentation of data will be effected by limiting the discussion largely to the influence of mineral salts on the first or carbonaceous stage of deoxygenation. Under these conditions, as will presently be shown, the adjustment of such variables as the pH value and the dissolved oxygen content is not critical. In fact, within wide limits, the nature and the concentration of the mineral salts themselves may be of little consequence, provided that some degree of mineralization is afforded. The more formidable array of variables encountered in studies of nitrification will be considered in a separate paper.

EXPERIMENTAL PROCEDURE

It was apparent in preliminary studies that the effect, if any, produced by certain variations in technique was so small as to be practically within the limits of experimental error. For this reason, whenever possible, all work was done in duplicate so that the experimental error in any given experiment is well-defined. Moreover, in order that systematic deviations due to the dilution water itself might be eliminated, it was decided that all work should be done at two different concentrations. For reasons already noted, it was also considered advisable to obtain several points along the deoxygenation curve, so that the trend under various experimental conditions would be accurately defined with samples in various stages of oxidation. While these analytical safeguards would be needlessly severe in routine determinations, they have not appeared unreasonable for the purpose at hand.

Following this general method of procedure, it was evidently necessary to make provision for the preparation of very large numbers of subsamples of a given diluted sample. This was done by adding suitable amounts of the sample to measured volumes of dilution water contained in 20-liter carboys. After thorough mixing, the mixture was siphoned to glass-stoppered bottles of approximately 300 milliliters capacity. In certain experiments, 8 or 10 carboys of 20 liters capacity were required and the number of 300-milliliter bottles filled from these carboys may have exceeded 200. Whenever the time required for the setting up of an experiment was considerable, special precautions were taken to avoid unevenness of sampling.

In all experiments the temperature of incubation was maintained within one degree of 20° C. At the start of a test the dissolved oxygen content was adjusted to about 9.0 parts per million by the application of suction to partly filled carboys in case the dilution water was supersaturated with oxygen or by storage at room temperature when an insufficient amount of oxygen was present.

For reasons which will be discussed more fully elsewhere, it was not considered necessary to use the Rideal-Stewart (permanganate) modification of the Winkler method unless nitrites to the extent of 0.1 parts per million or more were present in the diluted samples. The titrations were invariably performed with 0.025 M sodium thiosulphate, using a volume of iodine solution corresponding to 200 milliliters of the original sample.

The dissolved oxygen determinations in most experiments were paralleled by nitrite determinations. For obvious reasons, these two tests could not be made on the same subsample. It is believed, however, that the trend at least is very well shown by this procedure even though the nitrite results in certain instances may not be actually synchronized with the oxygen demand tests.

In all experiments the results obtained have been referred to the original waste. Thus, the observed loss of oxygen with a 2 percent mixture of sewage has invariably been multiplied by 50 to obtain the loss which might have been observed in the undiluted sample. The nitrite results, likewise, have been referred to the original sample by the application of a suitable factor, generally 25 or 30.

The tests described in this paper were invariably made on sewage samples and not on synthetic mixtures. In some experiments use was made of catch samples collected from a small sewer (Third Street, Cincinnati, Ohio) into which acid wastes from a glass-etching plant are intermittently discharged throughout the day. Although the use of sewage which was actually acid was avoided by preliminary tests of alkalinity and pH, it is believed that in several instances the seeding may have been considerably reduced by prior scouring of the sewerage system with spent acids. On the basis of extended bacteriological tests the total count on agar at 20° C. for this sewage is generally in the neighborhood of 100,000. This figure may be compared with a count of about 1,000,000 per cubic centimeter in "normal" sewage. The inclusion of results obtained with this sewage appears justifiable in exemplification of certain trends which have not hitherto been observed in this laboratory.

In other experiments the sewage sample was drawn from a large tank used in other experiments for the storage of night sewage from the Third Street sewer. This sewage is presumably free from acid waste and is reasonably representative of residential wastes.

As a third source of experimental material, catch samples of 1 gallon were collected from a very large sewer (Walnut Street) which drains the downtown districts of Cincinnati. There is no evidence of the presence of inhibitory wastes in this sewage and it may be regarded as fairly representative of average city sewage.

Unless specific mention to the contrary is made, it will be understood that reliance for seeding was placed wholly on the organisms present in the sewage as collected or by chance contamination of the apparatus and of the dilution waters.

The distilled water used in these experiments was prepared from Cincinnati tap water using a Barnstead still, which, as a rule, was operated at a high rate. Under ordinary conditions of collection and storage this distilled water is generally contaminated with bacteria and it possesses a small, but measurable, oxygen demand. This is shown in Table 4, where average results are presented with freshly prepared distilled water and with the same water after a preliminary period of 30 days at 20° C. For these vanishingly small oxygen demand values the usual titration error of about 0.03 parts per million may exceed the actual oxygen requirement of the distilled water, at least over the shorter periods of incubation. It is to be expected, however, that the titration error will balance out when several determinations are averaged. In Table 4 a reasonable degree of orderliness was secured by averaging six observations (three observations on a given day by each of two observers). On the basis of these experiments, no correction for the oxygen demand of the distilled water itself has been applied in any of the experiments presented in this paper.

TABLE 4.—*The oxygen demand of distilled water*

Preliminary period of storage, days	Period of incubation, in days					
	1	2	3	6	8	10
	Oxygen demand, parts per million					
1	0.05	0.08	0.09	0.15	0.15	0.17
30	.00	.02	.09	.07	.08	.11

PRECISION OF THE BASE DATA

In comparisons of oxygen demand results obtained under various experimental conditions it is fair to assume that, in terms of actually measured depletions, the standard deviation will be about 0.10 part per million irrespective of the magnitude of the observed depletion. (*Cf.* Theriault, 1927, pp. 152–164.) The error in question arises from inevitable inaccuracies in titrations and in other manipulations, including laboratory sampling. When depletions of 1.00 and 4.00 parts per million are obtained with 2 per cent mixtures of sewage, the corresponding oxygen demand values become 50 ± 5 and 200 ± 5. While the percentage error varies from 2.5 to 10 per cent, the error in parts per million is the same in each case. As an indication of experimental precision, duplicate determinations at the same concentration of sewage giving 50 and 55 parts per million in 1-day observations are to be regarded as favorably as the corresponding 5-day results of, say, 200 and 205 parts per million. In comparisons of oxygen demand values obtained with different concentrations of sewage, allowance should be made for an expected experimental error of 7 or 8 parts per million. On this basis an allowance should be made of about 10 parts per million when results with different dilution waters are compared. Systematic divergencies or trends may, of course, be superimposed on the usual plus or minus errors of observations.

GENERAL DESCRIPTION OF THE EXPERIMENTS

In general outline, the order of presentation of the data will be as follows:

1. In series A, B, C, and D the results obtained when ordinary distilled water was used as a diluent will be compared with similar

results using various mineralized waters. The concentration of the mineral salts used in these experiments was selected arbitrarily.

2. In other experiments (series E to J), the effect of varying the concentration of the mineral salts will be considered and more extended comparisons will be made of various mineralized solutions.

3. Consideration will next be given to the effect of variations in the pH value of the various dilution waters (series K to N).

4. Comparative tests on tap waters and synthetic dilution waters will then be presented (series N).

5. Finally, attention will be paid to the character of the seeding as a possible cause of observed differences in the results obtained under different experimental conditions (series O).

RESULTS WITH DISTILLED WATER AS THE DILUENT

The results presented in Table 5 were obtained in three series of experiments (July 8, 10, and 15, 1929) with different sewage samples using ordinary distilled water as the diluent. The alkalinity of the sewage samples was 145, 120, and 105 parts per million, respectively, in series A, B, and C. The corresponding pH values of the undiluted sewage were 7.5, 7.5, and 7.2. In each case the only mineral salts present were those added along with the sample itself.

TABLE 5.—*Series A, B, and C—Results with distilled water as the diluent*

Series	Concentration of sewage, per cent	Period of incubation, in days: 0	1	2	3	5	7	10
		Duplicate oxygen demand results, parts per million						
A	2.5		85	125	153	239	263	273
			87	131	149	lost	251	271
	5.0		87	139	([1])			
			83	136	([1])			
B	1		(10)	180	205	285	325	365
	2		83	193	283	363	346	376
			76	210	238	338	346	353
	4		141	([1])				
C	1		(17)	147	202	357	377	442
	2		108	208	235	288	328	380
			52	218	228	348	325	368
	4		146	196	([1])			
		pH values						
A	2.5	7.1	6.6	5.6	5.9	5.6	5.6	5.6
B	2.0	8.0	7.3	8.5	8.1	8.0	8.0	8.2
C	2.0	9.2	8.3	7.1	6.9	6.7	6.7	6.8
		Relative oxygen demand [2]						
A			36	56	63	(100)	108	114
B			30	59	74	(100)	103	111
C			31	58	67	(100)	104	120
Average			32	56	68	(100)	105	115

[1] Depleted.

[2] Basis of the average values, omitting 2 bracketed items. The average 5-day demand has been arbitrarily assigned a value of 100.

In series A the diluted mixtures contained 2.5 and 5.0 per cent of sewage. The 2.5 per cent mixture accordingly contained at least $0.025 \times 145 = 3.6$ parts per million of mineral salts and the 5.0 per cent mixture contained twice as much.

In series B and C, the mixtures used contained 1, 2, and 4 per cent of sewage. Owing to the added number of bottles required, duplicate tests were made only with the 2 per cent mixture.

The pH value at the start of the experiment in Series A was 7.1 on the basis of measurements made on the 2.5 per cent mixture. In the series B and C, the pH values at the start were 8.0 and 9.2, respectively, in the 2 per cent mixtures. These relatively high values are due to the use of tap water instead of distilled water for rinsing the bottles and carboys prior to use. By reason of excess lime treatment, the pH value of Cincinnati tap water is frequently in the neighborhood of 9 to 10. Traces of this water would, of course, greatly influence the pH value of unbuffered distilled water, although the mineral salt content would not be appreciably affected.

In series A, with the highest content of extraneous mineral salts and the lowest pH value, there is good agreement between duplicate observations using either 2.5 or 5.0 per cent of sewage.

In series B and C the agreement between duplicates (2 per cent mixtures) is occasionally good, but the agreement between the three different concentrations (1, 2, and 4 per cent) is poor. There is evidence of a marked lag when the results obtained during the first few days are compared. In series B this difference persists to the tenth day, while in series C the 1 per cent mixture gives relatively high results beyond the fifth day.

The unsatisfactory results obtained in series B and C, in comparison with series A, might be ascribed to pH effects, although the evidence is doubtful beyond the first day. Differences in the mineral salt content of the diluted mixtures due to varying concentrations of sewage are also to be considered, although the total concentration of extraneous mineral salt in each experiment was small. In fact, when the average values are placed on a comparable basis (see lower part of Table 5), the trend in each series of observations appears to have been very much the same. In deriving these relative values, the average values obtained in a given series of observations were first divided by the corresponding 5-day oxygen demand. The quotients obtained were then multiplied by 100.

Using the same sewage samples and following the same general procedure, comparative tests were also made with bicarbonate dilution water (500 parts per million $NaHCO_3$) and with Formula C water. With bicarbonate dilution water (see Table 6), the agreement between duplicates was excellent in all three experiments. The agreement between different concentrations, however, is only fair in series B and C. As indicated by the relative values given at the bottom of Table 6, the course of the deoxygenation was substantially the same in each series of experiments with bicarbonate dilution water.

As a rule, the agreement between results obtained with different concentrations of sewage in bicarbonate dilution water has been better than that shown in series B and C. In good measure this may have been due to the use in early experiments of a sample of sodium bicarbonate which, through aging, may have contained a considerable proportion of carbonate. This is indicated by the relatively high pH value of the bicarbonate mixtures. In all subsequent work use was made of a fresh supply of the salt which was preserved in a tightly stoppered bottle. It is also to be noted that 500 parts per million of $NaHCO_3$ were used in these experiments.

TABLE 6.—*Series A, B, and C—Results with bicarbonate water as the diluent*

Series	Concentration of sewage, per cent	Period of incubation, in days: 0	1	2	3	5	7	10
		Duplicate oxygen demand results, parts per million						
A	2.5	-------	120	170	210	254	280	298
		-------	118	164	210	270	272	296
	5.0	-------	124	166	(1)	-------	-------	-------
		-------	124	162	(1)	-------	-------	-------
B	1	-------	115	205	245	375	395	415
	2	-------	142	222	292	352	362	382
		-------	152	217	287	367	362	384
	4	-------	173	(1)	-------	-------	-------	-------
C	1	-------	150	220	305	415	475	520
	2	-------	172	258	360	(1)	-------	-------
		-------	178	258	360	425	-------	-------
	4	-------	182	(1)	-------	-------	-------	-------
		pH values						
A	2.5	9.7	7.7	7.6	7.6	7.3	7.7	7.7
B	2.0	8.2	8.2	8.1	7.9	8.0	8.0	7.9
C	(2)	-------	-------	-------	-------	-------	-------	-------
		Relative oxygen demand [3]						
A	-------	-------	47	63	80	(100)	105	113
B	-------	-------	40	59	75	(100)	102	108
C	-------	-------	40	58	81	(100)	113	124
Average	-------	-------	42	60	79	(100)	107	115

[1] Depleted.
[2] No test made.
[3] Basis of the average values. The average 5-day demand has been arbitrarily assigned a value of 100.

With Formula C water (Table 7) the agreement between duplicate determinations is very satisfactory throughout and, on the whole, the agreement using different concentrations is also good. It is evident, from the values given at the bottom of Table 7, that the relative amount of oxygen used up on a given day was very much the same with all three samples.

It is noteworthy that with Formula C water there is little evidence of lag with the lower concentrations during the first few days of incubation. Using distilled water (Table 5), the average results obtained on the first day in series B with 1, 2, and 4 per cent mixtures were 10, 80, and 141 parts per million, respectively. With bicarbonate water (Table 6) the corresponding averages were 115, 147, and 173. These results are somewhat closer together than the preceding set, although the absolute agreement still leaves much to be desired. With Formula C water (Table 7) the same sewage mixtures lead to 1-day values of 170, 172, and 178 parts per million. These results show a slight trend, although the general agreement is within the experimental error. It is significant that the highest value (173) obtained with bicarbonate water was also of the same order of magnitude.

TABLE 7.—*Series A, B, and C—Results with Formula C as the diluent*

Series	Concentration of sewage, per cent	Period of incubation, in days: 0	1	2	3	5	7	10
		Duplicate oxygen demand results, parts per million						
A	2.5	-------	137	179	215	255	275	305
		-------	138	185	217	267	275	273
	5.0	-------	142	(1)	-------	-------	-------	-------
		-------	144	(1)	-------	-------	-------	-------
B	1	-------	170	235	290	335	365	395
	2	-------	175	248	275	328	352	370
		-------	170	248	290	342	348	375
	4	-------	178	(1)	-------	-------	-------	-------
C	1	-------	202	287	312	392	422	462
	2	-------	190	230	308	375	412	(1)
		-------	188	268	320	375	410	(1)
	4	-------	183	(1)	-------	-------	-------	-------
		pH values						
A	2.5	7.4	6.9	6.9	6.9	6.8	6.9	7.0
B	2.0	7.2	7.1	7.0	7.0	6.9	6.9	7.0
C	2.0	7.3	7.1	6.9	7.0	6.9	6.9	7.1
		Relative oxygen demand [2]						
A	-------	-------	54	70	83	(100)	105	111
B	-------	-------	52	73	85	(100)	106	113
C	-------	-------	50	69	82	(100)	109	121
Average	-------	-------	52	71	83	(100)	107	115

[1] Depleted.
[2] Basis of average values. The average 5-day demand has been arbitrarily assigned a value of 100.

To facilitate the further comparison of the results obtained in these three experiments with different dilution waters, the average values obtained in each experiment have been summarized in Table

8. Without exception the lowest values were obtained with distilled water. Bicarbonate water gave lower results than Formula C water during the first few days. Thereafter the results with bicarbonate water are equal to or higher than those obtained with Formula C water. As indicated in the lower part of Table 8, the relative values obtained over the usual 5-day period of incubation are 100, 106, and 92, respectively, for Formula C water, bicarbonate water, and distilled water. When the relative values obtained with bicarbonate water and with Formula C water are compared, it is apparent that, for most practical purposes, the differences observed would not be damaging. It is significant, nevertheless, that systematic differences do exist which, as indicated by the excellent agreement between strict duplicates, can not be ascribed to experimental errors.

TABLE 8.—*Series A, B, and C—Average results with different diluents*

Series	Dilution water used	Period of incubation, in days: 1	2	3	5	7	10
		Average oxygen demand, parts per million					
A	Distilled	86	133	151	239	257	272
	Bicarbonate	122	166	210	262	276	297
	Formula C	140	182	216	261	275	289
B	Distilled	100	194	242	329	339	365
	Bicarbonate	146	215	275	365	373	394
	Formula C	173	244	285	335	355	380
C	Distilled	102	192	222	331	343	397
	Bicarbonate	170	245	342	420	475	520
	Formula C	191	262	313	381	415	462
		Relative oxygen demand [1]					
A	Formula C	54	70	83	(100)	105	111
B		52	73	85	(100)	106	113
C		50	69	82	(100)	109	121
Average		52	71	83	(100)	107	115
A	Bicarbonate	47	64	80	100	106	114
B		44	64	82	109	111	118
C		45	64	90	110	125	136
Average		45	64	84	106	114	123
A	Distilled	33	51	58	92	98	104
B		30	58	72	98	101	109
C		27	50	58	87	90	104
Average		30	53	63	92	96	106

[1] For each series of observations, the 5-day oxygen demand obtained with Formula C water has been assigned the arbitrary value of 100.

The samples used in series A, B, and C were drawn from the Third Street sewer on the day of the tests. Better agreement was obtained in series D when use was made of sewage from the same source composited throughout the night so as to exclude acid wastes. In addition to the dilution waters already used, comparative tests were also made with phosphate dilution water containing 5 milliliters of stock buffer solution per liter.

As shown in Table 9, the agreement between duplicates at each of two concentrations of sewage (2 and 4 per cent) is excellent throughout. Excepting the results obtained on the second day with distilled water, the agreement between different concentrations is likewise very good. The nitrite content, referred to the undiluted samples, ranged from 0.25 to 0.50 parts per million at the start, and it decreased during the first five days, presumably as the result of air oxidation. Between the seventh and eleventh days, however, there is unmistakable evidence of nitrite formation, except in Formula C water. The increase, however, was not great enough to exert a material effect on the oxygen demand values.

The average values presented in Table 9 indicate good agreement between the results obtained with the bicarbonate and the phosphate waters. The results with Formula C water are relatively high. Distilled water, as in series A, B, and C, gave results which, while consistent among themselves, are relatively low.

TABLE 9.—*Results with four dilution waters*

Dilution water used	Sewage concentration, per cent	Period of incubation, in days: 1	2	5	7	11
		Oxygen demand, parts per million				
Distilled	2	38	50	112	123	134
		38	52	104	125	134
	4	42	69	114	124	142
		42	70	110	124	144
Bicarbonate	2	52	77	127	142	160
		50	73	133	144	162
	4	52	82	125	137	152
		52	82	127	134	156
Phosphate	2	52	75	119	125	158
		58	73	121	142	154
	4	51	79	117	131	154
		50	80	119	131	155
Formula C	2	58	93	131	147	176
		58	87	131	152	166
	4	56	87	127	144	158
		58	88	128	144	157
		Relative oxygen demand [1]				
Distilled	2, 4	36	55	(100)	113	125
Bicarbonate	2, 4	41	61	(100)	109	123
Phosphate	2, 4	45	65	(100)	111	130
Formula C	2, 4	44	69	(100)	114	127

[1] Basis of the 5-day results obtained with each dilution water.

The relative oxygen demand values given in Table 9 were obtained, as before, by assigning an arbitrary value of 100 to the 5-day oxygen demand values obtained with each dilution water. The course of the deoxygenation was evidently much the same with the three mineralized waters. For the first 5 days these relative values are in good agreement with those obtained in series A, B, and C (Tables 5, 6, and 7) with the corresponding dilution waters.

EFFECT OF VARIATIONS IN THE MINERAL SALT CONTENT OF FORMULA C DILUTION WATER

The results obtained when the mineral salt content of Formula C water was varied from 87 to 348 parts per million are given in Table 10 (series E). The source of the sewage sample was the same as that in series D (composited night flow). The pH value of the sewage was 7.5.

Irrespective of mineral salt concentration, the agreement between duplicate determinations using 2 or 4 per cent of sewage is very satisfactory. The agreement between results obtained with different concentrations of sewage is likewise good up to the tenth day when active nitrification was first observed. As shown by the average values given at the bottom of Table 10, there is a slight but nevertheless distinct tendency toward progressively lower results as the concentration of mineral salts is increased. The difference, however, is within the expected experimental error.

TABLE 10.—*Series E—Effect of variation in the mineral salt content of Formula C water*

Concentration of mineral salts, parts per million	Sewage concentration, per cent	Period of incubation, in days: 2	3	5	7	10
		Oxygen demand, parts per million				
348	2	120	150	200	207	230
		117	160	192	217	225
	4	132	154	188	219	243
		132	158	191	217	244
174	2	126	159	203	215	245
		124	157	208	222	240
	4	123	163	198	221	237
		136	165	200	220	243
87	2	140	163	215	216	241
		137	160	210	220	240
	4	133	165	199	220	244
		135	163	199	216	241
		Nitrite nitrogen, parts per million				
348	2	--------	--------	0.35	0.35	0.35
	4	--------	--------	.38	.38	2.5
174	2	--------	--------	.35	.35	1.5
	4	--------	--------	.38	.50	3.0
87	2	--------	--------	.35	.35	1.0
	4	--------	--------	.38	.38	1.5
		Average oxygen demand, parts per million				
348	2, 4	125	156	193	215	236
174	2, 4	127	161	202	220	241
87	2, 4	136	163	206	218	242

The 5-day oxygen demand in each of these three experiments at different concentrations of mineral salts was in the neighborhood of 200 parts per million, corresponding to an observed reduction of about 8 parts per million in the dissolved oxygen content of the diluted samples which contained 4 per cent of sewage. The dissolved oxygen content of the 4 per cent mixtures was around 8.7 parts per million at the start of the test, and on the fifth day this figure had been reduced to about 0.7 part per million. In order to continue the experiment with the 4 per cent mixtures, the contents of the 300-milliliter bottles used for incubation purposes were poured into a large container and reaerated by agitation in the presence of air. The 300-milliliter bottles were then refilled by siphoning, and a new figure was obtained for the dissolved oxygen content.

It is noteworthy that this treatment of the 4 per cent mixtures was without effect on the subsequent agreement on the seventh and tenth days with the 2 per cent mixtures which were left undisturbed. From this and numerous other experiments (*cf.* Theriault and Hommon, 1918) it might appear reasonable to conclude that the rate and extent of deoxygenation are not greatly affected even by extreme fluctuations in the dissolved oxygen content of diluted samples. In the light of present knowledge, however, this conclusion must be restricted to the first or carbonaceous stage of oxidation, as ample evidence now exists that nitrification is adversely affected when the dissolved oxygen content falls to 2 parts per million or less, corresponding to a depletion of over 75 per cent under ordinary conditions.

Another set of observations (series F) with Formula C water is given in Table 11, together with comparative results using bicarbonate water and the same sample of sewage. In each case the values given are averages of closely agreeing duplicate determinations at two concentrations. As before, the results appear progressively lower as the mineral salt content of Formula C water is increased. Throughout this series of observations the results with bicarbonate water are from 5 to 10 per cent higher than the highest results obtained with Formula C water. It is of interest to note, however, that this disagreement refers only to the extent and not to the rate or the course of the deoxygenation. This is shown by the relative values given in Table 11, where the 5-day demand in each of the four experiments has been assigned a value of 100. The agreement between these relative oxygen demand values is striking.

Table 11.—*Series F—Effect of variation in the mineral salt content of Formula C water*

Dilution water used	Concentration of mineral salts, parts per million	Sewage concentration, per cent	Period of incubation, in days: 1	2	3	5	7	10	15	17	20	24	27	30
			Average oxygen demand results, parts per million											
Formula C	348	2, 4	46	67	82	98	109	122	----	----	----	----	----	----
Do	174	2, 4	46	66	83	103	112	126	----	----	----	----	----	----
Do	87	2, 4	50	72	92	111	120	138	146	154	160	181	192	204
Bicarbonate	300	2, 4	52	77	97	120	132	148	162	165	172	198	214	219
			Relative oxygen demand results											
Formula C	----	----	47	68	84	100	111	124	----	----	----	----	----	----
Do	----	----	45	64	81	100	109	122	----	----	----	----	----	----
Do	----	----	45	65	83	100	108	124	131	139	144	163	173	184
Bicarbonate	----	----	43	64	81	100	110	123	135	138	143	165	178	182

Mention should be made of the fact, that, on the basis of repeated examinations for nitrites and free ammonia, nitrification did not take place in this particular experiment, although nitrification has generally been observed both with Formula C and bicarbonate dilution waters. While direct observations were not made, the absence of a seeding of nitrifying organisms in this particular sample of sewage does not appear improbable.

Owing to the expected exhaustion of dissolved oxygen the 4 per cent mixtures were reaerated on the seventeenth day. The 2 per cent mixtures were likewise reaerated on the twentieth day. As in series E this procedure was without effect on the subsequent agreement between the 2 and 4 per cent mixtures.

EFFECT OF VARIATIONS IN THE MINERAL SALT CONTENT OF THE BICARBONATE DILUTION WATER

The effect of variations in the mineral salt content of bicarbonate dilution water is shown by the duplicate observations (series G) presented in Table 12. The agreement between duplicates at a given concentration of sewage (2 or 3 per cent) or of mineral salts (75 to 300 parts per million) is excellent. On the whole, however, the results with 2 per cent of sewage are distinctly lower than in the 3 per cent mixture. When average values are compared the results with 75, 150, and 300 parts per million are well within an allowable error of 10 parts per million.

TABLE 12.—*Series G—Effect of variations in the mineral salt concentration of bicarbonate dilution water*

Concentration of $NaHCO_3$, parts per million	Sewage concentration, per cent	Period of incubation, in days: 1	2	3	5	7	10
		Oxygen demand, parts per million					
300	2	38	60	77	98	122	136
		42	60	83	104	145	135
	3	39	64	87	108	124	140
		46	66	87	109	136	134
150	2	32	56	66	92	112	126
		32	56	69	93	110	124
	3	43	65	86	110	123	130
		39	65	89	109	125	134
75	2	37	56	78	101	118	126
		37	59	74	96	123	126
	3	38	62	99	100	116	129
		35	63	75	103	119	129
		Average oxygen demand, parts per million					
300	2, 3	41	62	84	105	132	136
150	2, 3	36	60	78	101	118	128
75	2, 3	37	60	82	100	119	128

In series H a comparison was made of bicarbonate dilution waters containing, respectively, 300 parts per million of $NaHCO_3$ and the molecular equivalent or 376 parts per million of $KHCO_3$. As shown in Table 13 the agreement between duplicates is generally very satisfactory. The agreement between results obtained with 1 and 2 per cent of sewage in sodium bicarbonate dilution water is excellent, except on the third day. These results are also in satisfactory agreement with the values obtained with 1 per cent of sewage in potassium bicarbonate dilution water. When 2 per cent of sewage was used, the results with potassium bicarbonate water appear relatively low. The sewage used in these experiments was a catch-sample collected from the Walnut Street sewer. The pH value of the sewage was 7.4.

TABLE 13.—*Series H—Comparison of bicarbonate dilution waters*

Dilution water used	Concentration of mineral salts, parts per million	Sewage concentration, per cent	Period of incubation, in days: 1	3	5	7	9
			Oxygen demand, parts per million				
$NaHCO_3$	300	1	87	164	228	256	263
			81	152	244	282	263
		2	83	188	242	252	268
			86	188	241	254	264
$KHCO_3$	376	1	72	172	235	295	277
			79	165	239	241	261
		2	70	167	213	235	236
			68	170	210	230	238

THE EFFECT OF VARIATIONS IN THE MINERAL SALT CONTENT OF THE PHOSPHATE DILUTION WATER

In series I the dilution water consisted of distilled water to which varying amounts of phosphate solution buffered at pH 7.2 were added. As shown in Table 14 the agreement between duplicates is excellent irrespective of the concentration of mineral salts or of sewage. On the first and third days, however, there is a marked discrepancy between the results obtained with different concentrations of sewage although subsequent agreement is very satisfactory, irrespective of the degree of mineralization or the amount of added sewage. The same tendency was manifested in series J (Table 15) where comparative tests with bicarbonate dilution waters and with Formula C water at pH 7.2 are also presented. In each case the agreement between duplicates is excellent. With increasing amounts of phosphate buffer the oxygen demand results appear progressively higher during the first five days. As already noted, Formula C water in full strength (348 parts per million) gives slightly lower results for the first five days. On the seventh day the general agreement is good with all five dilution waters and at each of the concentrations of sewage.

TABLE 14.—*Series I—Effect of variations in the mineral salt content of phosphate dilution water*

Concentration of mineral salts, parts per million	Sewage concentration, per cent	Period of incubation, in days: 1	3	5	7	9
		Oxygen demand, parts per million				
189	1	54	139	216	240	258
		49	139	207	238	255
95	1	57	137	224	226	249
		57	134	204	242	216
47	1	57	117	199	219	233
		59	114	205	214	236
189	2	65	164	205	232	234
		75	159	208	229	236
95	2	61	151	200	213	223
		66	153	200	232	226
47	2	67	155	214	230	241
		72	154	210	227	230
		Average oxygen demand, parts per million				
47-189	1	56	130	209	230	241
47-189	2	68	156	206	227	232

Table 15.—*Series J—Oxygen demand results with phosphate dilution water*

Dilution water used	Concentration of mineral salts, parts per million	Sewage concentration, per cent	Period of incubation, in days: 1	3	5	7	17: Observed	17: Corrected
			Oxygen demand, parts per million					
Phosphate	189	2	46	92	120	138	170	165
			51	88	115	148	192	187
		4	60	113	133	147	189	177
			60	112	129	148	206	194
Do	95	2	51	90	115	152	196	190
			54	87	112	148	195	190
		4	55	107	126	135	209	191
			56	107	125	142	202	184
Do	47	2	50	78	106	139	168	163
			50	82	106	142	182	177
		4	54	104	125	141	201	177
			54	103	125	143	210	186
Bicarbonate	300	2	52	85	110	140	210	186
			48	89	105	138	207	183
		4	57	107	133	144	209	185
			56	109	130	146	214	190
Formula C	348	2	55	85	108	139	220	190
			50	85	110	138	225	195
		4	54	99	117	132	208	179
			54	100	115	132	207	183
			Nitrite nitrogen, parts per million					
Phosphate	200	2	0.10	0.10	0.10	0.10	2.5	-------
		4	.05	.05	.05	.05	6.2	-------
	100	2	.10	.10	.10	.10	2.5	-------
		4	.05	.05	.05	.05	8.8	-------
	50	2	.10	.10	.10	.10	2.5	-------
		4	.05	.05	.05	.08	12.	-------
Bicarbonate	300	2	.10	.10	.15	.10	12.	-------
		4	.05	.05	.15	.18	12.	-------
Formula C	360	2	.10	.10	.10	.10	15.	-------
		4	.05	.05	.05	.10	12.	-------

As shown in Table 15, nitrification did not start in series J until after the seventh day. Active nitrification, however, was in progress on the seventeenth day, when the next observations were made. There is good correlation between the variations in the 17-day oxygen demand results and the corresponding degree of observed nitrite formation. This is shown in the last column of Table 15 where allowance for varying degrees of nitrification has been made by deducting two parts per million from the observed oxygen demand for each part per million of observed nitrite nitrogen. For all five dilution waters and for each of two concentrations of sewage the corrected values are in reasonable agreement with the general average of 183 parts per million for the corrected results obtained on the seventeenth day.

There is no evidence in these experiments of the catalytic activity claimed by Cooper and Reed (1927) for potassium acid phosphate.

THE EFFECT OF VARIATIONS IN pH

The effect of variations in pH on the rate and extent of deoxygenation of diluted sewage is shown in Table 16 (series K) by duplicate determinations using phosphate dilution waters adjusted to pH 8.3, 7.2, and 5.9. Parallel observations using bicarbonate dilution water (pH 8.0) are also included. The pH value of the sewage used in these experiments was 7.4. As usual, the agreement between duplicate determinations under any condition of test is excellent. When results with different concentrations of sewage are compared the best agreement is shown in the phosphate water buffered at pH 7.2. At other pH values there is a distinct tendency on the third day toward lower results with lower concentrations of sewage. On the whole, however, the general agreement is very satisfactory, irrespective of sewage concentration, pH value, and nature of the mineral salts. As shown by the nitrite nitrogen results, nitrification was just beginning on the tenth day in the samples buffered at pH 8.3 while a lesser degree of nitrification is indicated at pH 7.2 and 8.0.

TABLE 16.—*Series K—Effect of variations in pH*

Dilution water used	pH values		Concentration of sewage, per cent	Period of incubation, in days				
	At start	At finish		1	3	5	7	10
				Oxygen demand, parts per million				
Phosphate	8.3	7.8	2	48	75	142	168	151
				48	73	142	150	159
			3	48	105	133	148	157
				49	108	141	148	157
Do	7.2	7.0	2	50	112	146	153	156
				50	112	142	152	156
			3	48	107	138	148	166
				50	110	134	150	154
Do	5.9	6.4	2	41	91	135	142	147
				47	88	134	143	168
			3	43	103	130	145	150
				48	103	133	142	142
Bicarbonate	8.0	7.6	2	44	93	137	143	155
				40	96	131	147	153
			3	47	107	126	151	156
				47	108	128	156	159
				Average oxygen demand, parts per million				
Phosphate	8.3	7.8	2,3	48	90	140	154	156
	7.2	7.0	2,3	50	110	140	151	158
	5.9	6.4	2,3	45	96	133	143	152
Bicarbonate	8.0	7.6	2,3	44	101	130	149	156
				Nitrite nitrogen, parts per million				
Phosphate	8.3	7.8	2	0.20	0.20	0.20	0.20	1.5
	7.2	7.0	2	.20	.20	.20	.20	.50
	5.9	6.4	2	.20	.20	.20	.20	.20
Bicarbonate	8.0	7.6	2	.20	.20	.20	.20	.30

In series L the pH value of the sewage as drawn from a storage tank was 7.6. As shown in Table 17 by average values obtained from closely agreeing duplicate determinations, the agreement is good when the dilution was made with phosphate water buffered at pH 8.3 and 7.2 and also with Formula C water at pH 7.2. Using phosphate dilution water adjusted to pH 6.0, the oxygen demand values appear relatively low and, for the first few days at least, the agreement between the 2 and 4 per cent sewage mixtures is poorer than at higher pH values. The discrepancies, in any event, are small. Active nitrification was in progress at all pH values when this series of observations was terminated.

TABLE 17.—*Series L—Effect of variations in pH*

Dilution water used	pH values		Concentration of sewage, per cent	Period of incubation, in days					
	At start	At finish		1	2	4	7	10	11
				Average oxygen demand, parts per million					
Phosphate	8.3	7.8	2	51	95	126	156	162	164
			4	57	97	136	156	168	177
Do	7.2	7.1	2	54	90	136	162	187	171
			4	60	96	126	148	156	162
Do	6.0	6.0	2	48	72	102	138	154	153
			4	55	84	120	144	155	160
Formula C	7.2	7.2	2	60	92	122	138	155	157
			4	64	98	134	150	162	168

In series M the adjustment of pH was made by adding sodium carbonate (instead of sodium hydroxide) to solutions of potassium acid phosphate. The pH values selected for the experiment were 8.4, 8.0, and 7.2. After nine days of incubation these values had been reduced to 7.7, 7.3, and 7.1 in the 4 per cent sewage mixtures. The corresponding values in the 2 per cent mixtures were 7.9, 7.6, and 7.2. The pH value of the sewage was 7.4. As shown in Table 18 there is good general agreement between the results obtained at the neighboring value of pH 7.2. At higher pH values the agreement between strict duplicates is excellent but there is a pronounced trend when results with different concentrations of sewage are compared. There is some evidence in this series of experiments that a marked departure in the pH value of the dilution water from that of the undiluted sewage is unfavorable to the deoxygenation process. It should be noted, however, that the buffer strength of the solutions adjusted to pH 8.4 and 8.0 was very weak. In this respect these results are comparable with similar data presented by Garner (1922).

TABLE 18.—*Series M—Effect of variations in pH using phosphate-carbonate water*

pH values: At start	pH values: At finish	Concentration of sewage, per cent	Oxygen demand, parts per million — Period of incubation, in days: 1	2	4	6	9
8.4	7.9	2	40	67	101	117	124
			46	65	106	116	124
	7.7	4	55	84	111	124	139
			53	84	108	124	136
8.0	7.6	2	50	74	104	124	125
			47	74	103	124	130
	7.3	4	53	85	115	132	142
			53	87	112	125	133
7.2	7.2	2	47	76	118	130	139
			46	74	115	130	135
	7.1	4	53	87	116	132	141
			52	88	115	132	141

COMPARISONS OF TAP WATERS WITH SYNTHETIC WATERS

In series N (Table 19) a comparison was made of Cincinnati tap water with various synthetic dilution waters. In one case the tap water was stored for six days prior to the test, and its pH value was reduced from 8.7 to 7.4 by expired air. The pH value of the other tap water was 7.7. This water had been stored for several years, and it was filtered free from algal growths prior to the test. No corrections were applied for the oxygen demand of these dilution waters. The phosphate solution contained 47 parts per million of total solids. The bicarbonate solutions contained 300 and 376 parts per million, respectively, of $NaHCO_3$ and $KHCO_3$.

As shown in Table 19, two discordant results were obtained on the eighth day with the phosphate dilution water. As a rule, however, the general agreement is very satisfactory at all periods of incubation, irrespective of sewage concentration, pH adjustment, and even the nature of the added mineral salts. The experiments indicate that the substitution of synthetic dilution waters for tap waters will not lead to serious errors.

TABLE 19.—*Series N—Comparison of synthetic waters with Cincinnati tap water*

Dilution water used	pH value	Concentration of sewage, per cent	Oxygen demand, parts per million — Period of incubation, in days: 1	3	5	8
Phosphate	7.2	2	52	96	112	220
			48	102	120	152
		4	54	110	136	151
			53	112	119	195
Stored tap	7.4	2	53	110	136	166
			59	120	146	166
		4	54	112	134	138
			53	108	129	150
Do	7.7	2	50	108	140	170
			50	116	134	162
		4	52	109	131	146
			54	110	146	151
$KHCO_3$	7.8	2	42	96	140	164
			48	98	131	156
		4	53	111	135	164
			57	121	135	171
$NaHCO_3$	7.9	2	52	112	122	152
			48	106	122	162
		4	52	109	122	161
			53	110	128	154
Averages			52	109	131	162

DISCUSSION

In the experiments thus far presented, attention has been paid to factors such as the absence of mineral salts in the dilution water, the nature or concentration of the added mineral salts, and the pH value of the dilution water. As a rule, the tests were made in duplicate, at two different concentrations of sewage, and the observations were extended until the definite onset of the nitrification stage. To avoid repetition, these detailed experiments have been presented with a minimum of discussion. Consideration will now be given to certain points of agreement which are common to all experiments.

As regards agreement between duplicate determinations at any given strength of sewage and at all periods of observation, it must be concluded that, with mineralized dilution waters, the observed differences are generally within an expected experimental error of 5 parts per million. This conclusion appears warranted, irrespective of the nature or concentration of the added mineral salts and the pH value of the medium. Even with distilled water as a diluent, the agreement between strict duplicates is generally satisfactory.

If the comparison of results is extended to the average oxygen demand values obtained with different concentrations of sewage, it must be concluded that agreement within an expected experimental error of 7 or 8 parts per million has generally been observed on the first day and again after four or five days of incubation. Far greater discrepancies, however, have frequently been noted on the second or third day, the general tendency being towards lower results as the concentration of sewage is decreased. The conclusion appears warranted that these variations are to be correlated with differences of sewage concentration rather than with changes in the character of the dilution waters.

In the light of experiments conducted in this laboratory by Butterfield, Purdy, and Theriault (1930) it appears highly probable that discrepancies at intermediate periods of observation between oxygen demand results obtained with different concentrations of sewage are to be ascribed to a lag in the growth of plankton with a consequent reduction in the activity of the bacteria. As a rule the influence of the plankton is not exerted until after the first day, even with high concentrations of organic matter. The 1-day results, therefore, are not subject to variations from this source. Under favorable conditions of food supply, encysted forms of plankton present in the sewage will develop after 24 hours. In an unsuitable environment the growth of these organisms may be delayed or else the larger forms at least may fail altogether to develop.

Variations of a different type from those just considered have at times been observed in comparisons of average results obtained with various dilution waters or with the same water at different degrees of mineralization or at different pH values. The effect in question is most strikingly shown in series F (Table 11) where, in terms of percentage error, a constant difference was observed for 30 days between results obtained with Formula C and bicarbonate dilution waters.

Explanations based on sampling errors in the preparation of the diluted sewage mixtures appear to be ruled out, although in the complicated set-ups presented in this paper occasional errors of this character can not, of course, be definitely disclaimed. It appears more probable that the observed differences were due to the use in these experiments of a sewage which, as already explained, may have contained only a limited seeding of bacteria. Under these conditions, slight variations in the environment may result in the failure to grow of the single bacterial species present which is capable of oxidizing some important element of the food supply. With the more abundant seeding furnished by ordinary sewage, several varieties of bacteria may be introduced which are capable of performing the desired oxidation under a much greater range of variation in environmental conditions.

Direct evidence on this point has been furnished by Butterfield, Purdy, and Theriault (1930), who, in work, with limited seedings of known pure cultures, have clearly shown that as the complexity of the inoculation is gradually increased, progressively larger amounts of dissolved oxygen are absorbed from solutions of dextrose and peptone. Evidence based on the use of sewage mixtures will be given in the section which follows.

THE INFLUENCE OF VARIATIONS IN SEEDING

On the theory that the relatively low results obtained with distilled water as a diluent in series A, B, and C were due to the presence in the mineralized solutions used as controls of a more varied seeding of microorganisms, an attempt was made in series O to insure the practical absence from the mineralized solutions of bacteria other than those which thrive in distilled water. Sterilized sewage was accordingly used in this series of experiments instead of raw sewage as heretofore. As an additional precaution against gross contamination, sterile bottles and siphons were used. The distilled water used singly as a diluent or with the addition of mineral salts was drawn from a common container. This distilled water had been standing in the laboratory for several days and, of course, it was not sterilized as main reliance for seeding was placed on the organisms which it normally contains. In other respects the procedure followed was substantially the same as in series A, B, and C.

As shown in Table 20, the results obtained with this limited seeding of bacteria, plankton being presumably absent, were not as consistent as those obtained in previous experiments with mineralized dilution waters. The trend, nevertheless, is unmistakable. For the first three days the use of ordinary distilled water as a diluent led to results as good as or better than did the use of mineralized waters. It is noteworthy that on the first day no loss of dissolved oxygen occurred in bicarbonate water although, ultimately, this dilution water gave relatively high results. The virtual cessation of oxygen absorption beyond the fifth day may be credited to the absence of plankton.

TABLE 20.—*Results with a seeding of distilled water organisms*

Dilution water	Concentration of sewage, per cent	Period of incubation, in days: 1	2	3	5	7	9	10
		Oxygen demand, duplicates, parts per million						
Distilled	1	96	165	175	200	223	220	233
		97	168	178	222	260	250	-------
	2	86	145	182	191	221	201	208
		85	144	172	186	184	183	206
Phosphate	1	86	131	156	196	221	261	227
		81	134	183	261	208	244	242
	2	97	145	224	200	222	224	221
		90	161	193	220	218	225	214
Bicarbonate	1	0	166	165	230	243	252	258
		0	118	205	254	296	266	-------
	2	0	120	172	218	222	222	248
		0	120	172	212	242	238	-------
		Oxygen demand, averages, parts per million						
Distilled	1, 2	91	156	177	200	222	214	216
Phosphate	1, 2	88	143	189	219	217	238	226
Bicarbonate	1, 2	0	131	178	228	251	244	253

In other experiments use was made of a "synthetic" sewage (dextrose-peptone mixture) in which the development of very active strains of organisms had been secured by continued growth in the same medium over a period of three months. A sample of the synthetic sewage was sterilized and separate portions were then inoculated (*a*) with river water, (*b*) with fresh sewage, and (*c*) with liquor from the tank in which organisms acclimated to this synthetic sewage were growing. As shown in Table 21, the most vigorous oxidation was obtained with a seeding of tank liquor. As a control, the experiment was repeated with ordinary sewage, likewise sterilized and inoculated with the same material as before. As indicated in the lower part of Table 21, the results obtained with river water and with fresh sewage were in good agreement throughout. Distinctly lower results were obtained with a seeding of tank liquor.

The conclusion drawn from these and similar experiments is that the character of the seeding may be of much greater importance to the deoxygenation process than the nature of the mineral salts or the degree of mineralization.

TABLE 21.—*Effect of variations in seeding*

Source of sample	Nature of seeding	Period of incubation, in days			
		1	3	5	10
		Oxygen demand, parts per million			
Synthetic sewage [1]	River water	74	264	466	706
	Fresh sewage	134	262	592	670
	Tank liquor	372	720	850	882
		Oxygen demand, parts per million			
Ordinary sewage [1]	River water	62	158	206	248
	Fresh sewage	70	154	215	242
	Tank liquor	2	124	143	146

[1] Sterilized by autoclaving.

CONCLUSIONS

On the basis of the reasonably extensive series of observations presented in this paper, the conclusion appears warranted that the composition and the degree of mineralization of dilution waters for use in oxygen demand tests need not be critically adjusted, provided that the observations are restricted to the first stage of deoxygenation or to the first 8 or 10 days of incubation in work with sewage and industrial wastes.

In comparative tests and in other work where a maximum of precision is desired, especially for the first few days, consideration should be given to the character of the seeding as indicated by the presence of plankton capable of growing in highly diluted sewage and by the presence of a general infection of aerobic bacteria. As a rule these conditions will be automatically fulfilled in work with ordinary sewage. In any event, these exceptional precautions should seldom be required in the conduct of the usual 5-day oxygen demand test.

Preliminary studies of nitrification in dilute sewage mixtures have indicated that the difficulties to be surmounted are essentially those inherent in the cultivation of pure cultures. The elaborate investigations of the soil microbiologists furnish a logical point of departure in the development of dilution waters for general use in work with partly purified effluents. It appears probable, for example, that a rough measure of pH control must be envisaged. It has also been shown that nitrite formation is dependent on the presence of relatively large amounts of dissolved oxygen. Although the reason is nowhere explicitly stated, this peculiarity of the nitrifying organisms may account for the 30 to 60 per cent rule given by the Royal Commission (British) on Sewage Disposal (*cf.* Theriault, 1927, p. 22) regarding permissible limits of oxygen depletion.

In determinations of the 5-day oxygen demand of raw sewage, using ordinary distilled water as the diluent, the results obtained have generally been 10 per cent lower than in comparative tests with mineralized dilution waters. Over shorter periods of incubation the percentage error may be considerably greater. It is to be noted, however, that in work with sewage effluents at dilutions of 1 to 5 or less, enough of mineral salts should be added along with the sample to furnish a suitable degree of mineralization. The favorable results reported by Cooper, Cooper, and Heward (1918) and others who have used distilled water in tests of sewage effluents may be due to the retardation of the nitrification process by the carbonaceous matters present in the river waters used as controls. With the development of readily prepared synthetic waters the use of distilled water for dilution purposes has become inadvisable.

In studies of the first stage of deoxygenation and with a view to the eventual development of a dilution water for general use in oxygen demand tests, it appears desirable to standardize on the readily prepared phosphate dilution water, without addition of other salts as in Formula C water. For more restricted use, particularly in the range of pH 7 to 8, it is clear, however, that the simple bicarbonate solution proposed by Mohlman and his associates may be fully as serviceable as the somewhat more complex phosphate mixtures. In this connection there is need for further information regarding the pH values reached by sewage effluents and, especially, the cultural characteristics of nitrifying organisms in the exceedingly dilute solutions encountered in sewage treatment.

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COURT DECISIONS RELATING TO PUBLIC HEALTH

Death resulting from drinking impure water held death by accident under workmen's compensation act.—(Indiana Appellate Court; State et al. *v.* Smith, 175 N. E. 146; decided Mar. 4, 1931.) An employee of the State highway commission became ill with gastroenteritis as a result of drinking some polluted water which was furnished to him while at work. Later pericarditis developed and death ensued. In a proceeding by the employee's widow under the workmen's compensation act, the appellate court affirmed the industrial board's award of compensation, holding that the death was one by accident within the meaning of the compensation law.

Silicosis resulting in tuberculosis held not an injury by accident under workmen's compensation act.—(Georgia Court of Appeals; Simmons *v.* Etowah Monument Co., 157 S. E. 260; decided Feb. 13, 1931.) An employee operated, in a closed room, an air hose through which sand was blown on the face of marble for the purpose of wearing off the marble. A considerable amount of sand and marble dust was thus created in the room. Because of a faulty construction and adjustment of the mask which had been furnished to the employee and which he was accustomed to wear over his head to prevent the inhalation of sand and marble dust, and because of the improper and insufficient ventilation of the room, he inhaled some of the particles of sand and dust. As a consequence, the employee contracted silicosis, which resulted in tuberculosis of the lungs. In a proceeding under the workmen's compensation act a denial of compensation was affirmed by the court of appeals. The court stated that a disease was not compensable under the act unless it resulted naturally and unavoidably from an injury or "accident" which arose out of and in the course of the employment, and that the fact that the disease itself was contracted by accident, in the sense that its happening was unforeseen or unexpected, did not render it compensable if it did not result from a previous injury or accident to the employee himself. In deciding that there had been no injury by accident, the court said:

> * * * Since an "injury," as defined in the compensation act, is "an injury by accident," in the sense of some damage or hurt to the employee, the mere lodging of the particles of dust and sand in the defendant's lungs constituted in itself no injury or accident to the employee in the sense of the act, other than the resulting disease itself, and the diseases of the lungs which resulted therefrom were not, for this reason, caused by any injury or accident to the employee. * * *

DEATHS DURING WEEK ENDED APRIL 18, 1931

Summary of information received by telegraph from industrial insurance companies for the week ended April 18, 1931, and corresponding week of 1930. (From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce)

	Week ended April 18, 1931	Corresponding week, 1930
Policies in force	75, 146, 342	75, 746, 314
Number of death claims	15, 930	13, 562
Death claims per 1,000 policies in force, annual rate	11. 1	9. 3

Deaths*[1] *from all causes in certain large cities of the United States during the week ended April 18, 1931, infant mortality, annual death rate, and comparison with corresponding week of 1930. (From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce)

[The rates published in this summary are based upon mid-year population estimates derived from the 1930 census]

City	Week ended Apr. 18, 1931				Corresponding week, 1930		Death rate[2] for the first 16 weeks	
	Total deaths	Death rate[2]	Deaths under 1 year	Infant mortality rate[3]	Death rate[2]	Deaths under 1 year	1931	1930
Total (81 cities)	8,884	13.0	797	[4] 62	12.9	750	13.9	13.3
Akron	44	8.9	6	59	11.0	8	8.7	8.8
Albany[5]	44	17.8	6	119	24.5	4	15.4	17.2
Atlanta	74	13.9	6	61	13.8	7	16.4	17.1
White	44	------	3	48	------	3	------	------
Colored	30	(6)	3	86	(6)	4	(6)	(6)
Baltimore[5]	248	15.9	21	71	14.7	16	17.2	15.7
White	179	------	16	69	------	14	------	------
Colored	69	(6)	5	78	(6)	2	(6)	(6)
Birmingham	88	17.0	4	40	13.6	7	15.9	14.4
White	49	------	2	34	------	2	------	------
Colored	39	(6)	2	49	(6)	5	(6)	(6)
Boston	232	15.4	25	71	17.4	35	16.5	16.2
Bridgeport	36	12.8	4	66	10.7	2	13.0	13.8
Buffalo	156	14.0	15	61	15.9	18	15.3	14.5
Cambridge	25	11.4	1	20	10.1	0	14.0	14.0
Camden	28	12.3	5	87	12.3	5	17.9	14.9
Canton	22	10.7	1	23	15.4	5	11.2	11.6
Chicago[5]	749	11.3	79	70	10.6	58	11.9	11.7
Cincinnati	169	19.3	8	48	16.0	10	18.1	17.5
Cleveland	225	12.9	20	58	14.0	15	12.7	12.5
Columbus	73	12.9	4	39	15.6	13	15.1	15.3
Dallas	72	13.8	8	------	11.7	6	12.8	12.6
White	49	------	6	------	------	4	------	------
Colored	23	(6)	2	------	(6)	2	(6)	(6)
Dayton	39	9.8	2	28	9.8	3	13.7	10.7
Denver	87	15.6	7	68	15.0	5	15.9	15.9
Des Moines	33	11.9	3	53	8.8	1	12.2	12.5
Detroit	297	9.4	43	69	10.3	41	9.7	10.6
Duluth	24	12.3	2	49	12.3	1	12.0	11.6
El Paso	31	15.4	4	------	13.2	5	18.3	18.4
Erie	28	12.4	4	75	10.3	2	11.7	11.2
Fall River[5] [7]	22	10.0	1	23	18.5	3	13.7	14.4
Flint	26	8.3	4	51	6.9	6	7.9	10.2
Fort Worth	35	10.9	4	------	10.2	2	12.1	12.0
White	27	------	2	------	------	2	------	------
Colored	8	(6)	2	------	(6)	0	(6)	(6)
Grand Rapids	42	12.8	3	44	9.9	3	9.8	11.9
Houston	73	12.3	6	------	10.1	1	11.8	12.9
White	47	------	5	------	------	1	------	------
Colored	26	(6)	1	------	(6)	0	(6)	(6)
Indianapolis	101	14.2	7	58	17.3	7	15.4	16.3
White	93	------	7	66	------	7	------	------
Colored	8	(6)	0	0	(6)	0	(6)	(6)
Jersey City	68	11.1	7	62	13.8	5	13.6	12.9
Kansas City, Kans	34	14.4	4	82	11.5	4	15.5	12.6
White	23	------	3	74	------	4	------	------
Colored	11	(6)	1	127	(6)	0	(6)	(6)
Kansas City, Mo	115	14.7	17	129	12.5	8	15.3	14.4
Knoxville	28	13.4	5	107	14.2	0	14.3	15.5
White	18	------	5	119	------	0	------	------
Colored	10	(6)	0	0	(6)	0	(6)	(6)
Long Beach	34	11.6	0	0	10.9	2	11.1	10.6
Los Angeles	294	11.6	28	81	10.2	15	11.7	12.1
Louisville	81	13.7	5	43	13.9	3	17.3	14.8
White	60	------	5	49	------	3	------	------
Colored	21	(6)	0	0	(6)	0	(6)	(6)
Lowell[7]	23	11.9	2	51	16.0	4	14.6	15.0
Lynn	21	10.7	0	0	12.2	1	12.3	12.3
Memphis	101	20.4	11	116	19.7	12	18.5	18.2
White	43	------	6	100	------	6	------	------
Colored	58	(6)	5	145	(6)	6	(6)	(6)
Miami	33	15.3	2	51	7.5	3	14.7	13.2
White	27	------	1	35	------	2	------	------
Colored	6	(6)	1	88	(6)	1	(6)	(6)

See footnotes at end of table.

***Deaths*[1] *from all causes in certain large cities of the United States during the week ended April 18, 1931*—Continued**

[The rates published in this summary are based upon mid-year population estimates derived from the 1930 census]

City	Week ended Apr. 18, 1931				Corresponding week, 1930		Death rate[2] for the first 16 weeks	
	Total deaths	Death rate[2]	Deaths under 1 year	Infant mortality rate[3]	Death rate[2]	Deaths under 1 year	1931	1930
Milwaukee	107	9.5	10	43	10.3	11	10.6	10.8
Minneapolis	106	11.7	12	77	12.5	10	12.3	11.3
Nashville	46	15.4	7	104	21.6	9	18.5	18.0
White	29		5	100		6		
Colored	17	(6)	2	118	(6)	3	(6)	(6)
New Bedford[7]	28	13.0	8	213	11.1	1	13.4	12.3
New Haven	38	12.2	3	57	15.7	1	13.6	14.5
New Orleans	140	15.6	9	49	18.9	15	19.3	19.5
White	77		5	41		13		
Colored	63	(6)	4	65	(6)	2	(6)	(6)
New York	1,686	12.4	150	66	12.2	133	13.4	12.2
Bronx Borough	230	9.0	19	43	8.3	10	9.6	8.7
Brooklyn Borough	583	11.6	59	63	10.8	43	12.4	11.3
Manhattan Borough	650	18.7	55	94	19.2	63	20.4	18.2
Queens Borough	185	8.4	24	66	7.1	17	8.6	8.0
Richmond Borough	38	12.1	2	36	17.3	0	14.2	15.3
Newark, N. J.	102	11.9	5	26	14.9	18	13.7	14.1
Oakland	55	9.8	4	51	9.5	4	12.0	12.0
Oklahoma City	45	11.9	2	28	11.1	3	12.3	10.7
Omaha	46	11.1	3	34	17.3	4	14.7	14.6
Paterson	55	20.7	6	103	14.7	3	15.9	13.5
Philadelphia	553	14.7	50	73	13.0	41	15.9	14.0
Pittsburgh	226	17.4	20	69	15.9	22	17.9	15.8
Portland, Oreg	68	11.5	1	12	12.2	3	12.7	13.7
Providence	75	15.3	4	37	15.4	8	15.2	15.6
Richmond	73	20.7	7	102	14.2	4	18.1	16.4
White	43		3	66		2		
Colored	30	(6)	4	174	(6)	2	(6)	(6)
Rochester	82	12.9	8	73	15.5	10	13.9	13.2
St. Louis	247	15.6	6	20	14.1	7	18.1	15.2
St. Paul	59	11.1	6	62	10.3	2	11.7	11.2
Salt Lake City[5]	32	11.7	1	15	8.1	2	13.3	14.3
San Antonio	80	17.4	18		19.7	14	15.2	18.5
San Diego	39	13.0	3	61	15.3	6	15.5	15.6
San Francisco	160	12.8	4	27	13.3	8	14.6	13.9
Schenectady	22	11.9	1	29	13.1	2	12.0	12.2
Seattle	95	13.3	2	19	11.4	4	13.3	12.0
Somerville	23	11.4	4	149	8.5	4	11.1	12.2
South Bend	15	7.2	0	0	10.4	4	9.2	10.0
Spokane	41	18.4	3	78	17.1	1	13.6	13.7
Springfield, Mass	40	13.7	4	61	10.4	2	13.9	14.3
Syracuse	56	13.7	3	36	12.4	3	12.9	13.0
Tacoma	31	15.0	6	154	12.2	3	15.1	13.6
Toledo	69	12.2	9	83	15.6	5	13.6	14.2
Trenton	49	20.6	3	52	15.2	3	19.9	17.9
Utica	31	15.8	1	26	19.5	5	16.7	16.9
Washington, D. C	149	15.8	9	50	17.8	12	18.3	16.3
White	96		5	41		7		
Colored	53	(6)	4	69	(6)	5	(6)	(6)
Waterbury	19	9.8	1	30	9.4	1	11.3	10.9
Wilmington, Del.[7]	28	13.7	2	43	12.2	5	16.8	15.9
Worcester	58	15.3	6	82	15.7	6	15.1	15.7
Yonkers	22	8.3	0	0	11.2	1	10.1	9.3
Youngstown	33	10.0	3	42	9.2	4	11.6	11.0

[1] Deaths of nonresidents are included. Stillbirths are excluded.
[2] These rates represent annual rates per 1,000 population, as estimated for 1931 and 1930 by the arithmetical method.
[3] Deaths under 1 year of age per 1,000 live births. Cities left blank are not in the registration area for births.
[4] Data for 76 cities.
[5] Deaths for week ended Friday.
[6] For the cities for which deaths are shown by color, the percentage of colored population in 1920 was as follows: Atlanta, 31; Baltimore, 15; Birmingham, 39; Dallas, 15; Fort Worth, 14; Houston, 25; Indianapolis, 11; Kansas City, Kans., 14; Knoxville, 15; Louisville, 17; Memphis, 38; Miami, 31; Nashville, 30; New Orleans, 26; Richmond, 32; and Washington, D. C., 25.
[7] Population Apr. 1, 1930; decreased 1920 to 1930, no estimate made.

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

CURRENT WEEKLY STATE REPORTS

These reports are preliminary, and the figures are subject to change when later returns are received by the State health officers

Reports for Weeks Ended April 25, 1931, and April 26, 1930

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended April 25, 1931, and April 26, 1930

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930
New England States:								
Maine	6	-------	16	6	2	30	0	0
New Hampshire	2	-------	-------	6	31	10	0	0
Vermont	-------	-------	-------	-------	1	80	0	0
Massachusetts	32	64	7	5	496	1,533	1	4
Rhode Island	9	6	1	-------	35	5	0	0
Connecticut	11	17	7	5	754	76	2	5
Middle Atlantic States:								
New York	95	143	[1] 21	[1] 47	2,367	1,898	7	12
New Jersey	59	127	8	14	930	1,360	6	7
Pennsylvania	87	102	-------	-------	4,485	1,205	10	19
East North Central States:								
Ohio	22	65	24	10	1,097	816	4	3
Indiana	34	13	21	-------	1,118	91	12	7
Illinois	77	163	5	9	1,861	794	23	12
Michigan	25	57	4	6	103	2,358	9	30
Wisconsin	12	18	77	22	729	159	2	2
West North Central States:								
Minnesota	14	8	1	2	105	272	2	3
Iowa	8	7	-------	-------	113	453	3	2
Missouri	39	32	27	12	454	108	16	9
North Dakota	1	3	-------	-------	14	26	1	2
South Dakota	4	1	-------	-------	46	110	3	1
Nebraska	6	20	-------	-------	3	531	0	0
Kansas	7	11	12	1	54	819	0	5
South Atlantic States:								
Delaware	2	-------	-------	0	168	16	0	0
Maryland [2]	14	20	16	19	1,392	68	1	2
District of Columbia	13	18	2	3	287	30	1	1
Virginia	-------	-------	-------	-------	-------	-------	-------	-------
West Virginia	10	10	17	44	67	103	2	2
North Carolina	17	19	15	25	818	24	5	5
South Carolina	14	20	703	502	199	90	2	1
Georgia	6	4	85	52	86	272	3	2
Florida	4	3	5	1	227	530	3	0
East South Central States:								
Kentucky	-------	-------			128	32	3	3
Tennessee	1	5	153	43	132	347	5	29
Alabama [3]	15	10	51	63	304	148	2	2
Mississippi	4	9	-------	-------	-------	-------	0	6
West South Central States:								
Arkansas	5	5	103	31	30	68	0	7
Louisiana	19	26	19	25	3	122	4	5
Oklahoma [4]	14	5	110	20	14	451	0	2
Texas	17	29	81	26	3	193	0	0
Mountain States:								
Montana	3	3	-------	-------	7	34	2	1
Idaho	2	-------	23	-------	-------	16	2	3
Wyoming	-------	1	1	-------	1	39	0	1
Colorado	5	15	-------	-------	158	993	0	2
New Mexico	1	6	56	-------	91	58	1	1
Arizona	4	2	5	4	17	68	0	6
Utah [2]	2	4	7	6	7	298	1	2
Pacific States:								
Washington	6	7	-------	-------	30	463	3	12
Oregon	5	11	97	29	187	71	0	0
California	56	49	276	22	1,558	2,399	7	5

[1] New York City only.
[2] Week ended Friday.
[3] Typhus fever, 1931, 2 cases in Alabama.
[4] Figures for 1931 are exclusive of Oklahoma City and Tulsa.

***Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended April 25, 1931, and April 26, 1930*—Continued**

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930	Week ended Apr. 25, 1931	Week ended Apr. 26, 1930
New England States:								
Maine	0	1	26	24	0	0	0	4
New Hampshire	0	0	6	24	0	0	0	0
Vermont	0	0	4	11	0	12	0	0
Massachusetts	2	0	384	297	0	0	3	4
Rhode Island	0	0	77	30	0	0	0	1
Connecticut	0	0	58	80	0	0	2	1
Middle Atlantic States:								
New York	3	1	966	504	2	1	9	14
New Jersey	0	1	338	231	0	0	5	4
Pennsylvania	1	2	634	406	0	0	6	6
East North Central States:								
Ohio	0	1	367	277	43	151	4	30
Indiana	0	0	216	170	125	182	4	3
Illinois	0	0	551	473	38	150	4	5
Michigan	1	1	293	319	39	52	3	7
Wisconsin	1	1	170	187	24	17	1	1
West North Central States:								
Minnesota	0	0	87	91	5	3	0	0
Iowa	0	0	75	75	81	102	1	0
Missouri	0	0	263	99	30	88	4	2
North Dakota	0	0	8	31	2	25	0	0
South Dakota	0	0	18	30	32	45	1	0
Nebraska	0	0	26	78	24	113	0	1
Kansas	1	0	59	110	136	104	3	2
South Atlantic States:								
Delaware	0	0	20	5	0	0	0	0
Maryland [2]	0	0	71	136	0	0	0	5
District of Columbia	0	0	28	10	0	0	0	0
Virginia	------	------	------	------	------	7	------	------
West Virginia	0	0	64	31	5	0	4	15
North Carolina	0	0	41	29	3	18	1	2
South Carolina	1	0	9	5	3	8	6	10
Georgia	0	0	69	21	0	0	3	6
Florida	0	0	4	3	0	0	2	2
East South Central States:								
Kentucky	0	0	49	22	14	7	1	2
Tennessee	0	0	41	65	17	10	4	12
Alabama [3]	0	0	19	9	4	9	2	2
Mississippi	1	0	14	9	51	27	3	4
West South Central States:								
Arkansas	0	0	26	4	51	8	7	4
Louisiana	0	1	23	18	36	19	9	22
Oklahoma [4]	1	0	37	55	60	145	11	3
Texas	0	0	43	42	54	87	10	9
Mountain States:								
Montana	0	0	45	38	2	13	1	4
Idaho	0	0	3	3	1	2	2	0
Wyoming	0	1	11	1	2	11	0	0
Colorado	0	0	30	22	2	4	1	0
New Mexico	0	0	4	13	1	11	5	2
Arizona	0	0	7	14	0	14	0	5
Utah [2]	1	0	10	8	0	0	1	2
Pacific States:								
Washington	0	0	23	31	23	63	4	3
Oregon	0	0	14	34	33	30	0	6
California	7	3	154	150	46	66	10	8

[2] Week ended Friday.
[3] Typhus fever, 1931, 2, cases in Alabama.
[4] Figures for 1931 are exclusive of Oklahoma City and Tulsa.

SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of cases reported monthly by States is published weekly and covers only those States from which reports are received during the current week.

State	Meningococcus meningitis	Diphtheria	Influenza	Malaria	Measles	Pellagra	Poliomyelitis	Scarlet fever	Smallpox	Typhoid fever
March, 1931										
California	20	222	2,633	3	5,969	-------	19	620	216	32
Louisiana	17	88	217	29	78	57	0	100	121	24
Maryland	1	64	549	1	4,829	-------	0	371	0	11
Michigan	60	160	572	1	789	-------	2	1,752	86	11
Minnesota	11	89	150	-------	455	-------	2	501	30	5
Missouri	47	208	540	7	1,853	1	0	1,591	213	31
North Carolina	21	104	519	-------	2,980	73	1	219	5	5
Rhode Island	1	26	9	-------	52	-------	0	266	0	0
West Virginia	4	33	575	-------	364	-------	0	118	56	16

March, 1931

	Cases
Actinomycosis:	
California	1
Chicken pox:	
California	2,509
Louisiana	86
Maryland	683
Michigan	1,574
Minnesota	783
Missouri	448
North Carolina	718
Rhode Island	93
West Virginia	343
Diarrhea:	
Maryland	4
Dysentery:	
California (amebic)	7
California (bacillary)	5
Maryland	1
Michigan	1
Minnesota	3
Minnesota (amebic)	2
Rhode Island	1
Food poisoning:	
California	72
German measles:	
California	79
Maryland	450
North Carolina	2,843
Rhode Island	5
Granuloma, coccidioidal:	
California	1
Hookworm disease:	
Louisiana	77
Jaundice:	
California	2
Maryland	7
Impetigo contagiosa:	
Maryland	3
Leprosy:	
California	3
Louisiana	1
Maryland	1
Lethargic encephalitis:	
California	8
Maryland	2
Michigan	5

	Cases
Mumps:	
California	1,492
Louisiana	10
Maryland	382
Michigan	618
Missouri	168
Rhode Island	128
Ophthalmia neonatorum:	
Maryland	1
North Carolina	2
Paratyphoid fever:	
California	1
Rabies in animals:	
California	107
Louisiana	7
Maryland	1
Missouri	2
Rhode Island	1
Scabies:	
Maryland	16
Septic sore throat:	
California	5
Maryland	13
Michigan	62
Missouri	50
North Carolina	4
Rhode Island	1
Tetanus:	
California	2
Louisiana	3
Missouri	1
Trachoma:	
California	12
Missouri	20
North Carolina	2
Trichinosis:	
Maryland	2
Tularaemia:	
Louisiana	4
Minnesota	1
Typhus fever:	
North Carolina	1
Undulant fever:	
California	9
Louisiana	2
Maryland	3
Michigan	2

Undulant fever—Continued.	Cases
Minnesota	3
Missouri	6
Vincent's angina:	
Maryland	17
Whooping cough:	
California	1,211
Louisiana	23

Whooping cough—Continued.	Cases
Maryland	124
Michigan	879
Minnesota	238
Missouri	107
North Carolina	637
Rhode Island	38
West Virginia	208

GENERAL CURRENT SUMMARY AND WEEKLY REPORTS FROM CITIES

The 98 cities reporting cases used in the following table are situated in all parts of the country and have an estimated aggregate population of more than 33,480,000. The estimated population of the 91 cities reporting deaths is more than 31,935,000. The estimated expectancy is based on the experience of the last nine years, excluding epidemics.

Weeks ended April 18, 1931, and April 19, 1930

	1931	1930	Estimated expectancy
Cases reported			
Diphtheria:			
46 States	929	1,078	
98 cities	424	544	800
Measles:			
45 States	20,732	17,848	
98 cities	8,447	7,742	
Meningococcus meningitis:			
46 States	142	244	
98 cities	78	119	
Poliomyelitis:			
46 States	24	7	
Scarlet fever:			
46 States	5,449	4,635	
98 cities	2,452	1,883	1,416
Smallpox:			
46 States	1,020	1,464	
98 cities	140	173	68
Typhoid fever:			
46 States	137	190	
98 cities	30	36	32
Deaths reported			
Influenza and pneumonia:			
91 cities	1,090	988	
Smallpox:			
91 cities	0	0	

City reports for week ended April 18, 1931

The "estimated expectancy" given for diphtheria, poliomyelitis, scarlet fever, smallpox, and typhoid fever is the result of an attempt to ascertain from previous occurrence the number of cases of the disease under consideration that may be expected to occur during a certain week in the absence of epidemics. It is based on reports to the Public Health Service during the past nine years. It is in most instances the median number of cases reported in the corresponding weeks of the preceding years. When the reports include several epidemics, or when for other reasons the median is unsatisfactory, the epidemic periods are excluded, and the estimated expectancy is the mean number of cases reported for the week during non-epidemic years.

If the reports have not been received for the full nine years, data are used for as many years as possible, but no year earlier than 1922 is included. In obtaining the estimated expectancy, the figures are smoothed when necessary to avoid abrupt deviation from the usual trend. For some of the diseases given in the table the available data were not sufficient to make it practicable to compute the estimated expectancy.

Division, State, and city	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
		Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
NEW ENGLAND								
Maine:								
Portland	3	1	0		0	0	11	2
New Hampshire:								
Concord	0	0	0		0	9	0	1
Manchester	0	0	0		0	0	0	8
Vermont:								
Barre	0	0	0		0	0	0	0
Burlington	0	0	0		0	0	0	0
Massachusetts:								
Boston	68	29	17	1	2	113	15	23
Fall River	3	2	3	1	1	7	8	2
Springfield	0	2	1		0	16	38	2
Worcester	7	4	1		0	4	12	0
Rhode Island:								
Pawtucket	2	0	0		0	0	0	1
Providence	8	7	6		0	34	9	10
Connecticut:								
Bridgeport	1	4	0		0	0	4	4
Hartford	3	4	5	1	0	56	1	9
New Haven	19	0	0		0	322	14	6
MIDDLE ATLANTIC								
New York:								
Buffalo	11	9	11	1	0	327	71	12
New York	430	250	96	13	13	1,618	98	238
Rochester	4	5	1	2	1	70	11	7
Syracuse	32	4	1		0	4	1	3
New Jersey:								
Camden	11	6	3	1	1	20	8	4
Newark	133	15	3	8	0	30	25	8
Trenton	3	3	1		0	11	3	7
Pennsylvania:								
Philadelphia	186	58	14	8	7	1,230	84	71
Pittsburgh	109	14	6	3	4	115	78	49
Reading	7	2	2		0	27	8	3
EAST NORTH CENTRAL								
Ohio:								
Cincinnati	6	6	3		2	128	23	19
Cleveland	222	24	11	32	6	82	439	23
Columbus	15	3	0	3	2	3	2	7
Toledo	32	3	2	3	2	9	27	6
Indiana:								
Fort Wayne	2	2	3		0	24	0	6
Indianapolis	36	4	1		0	287	26	16
South Bend	1	1	1		0	2	0	1
Terre Haute	2	1	1		0	1	0	2
Illinois:								
Chicago	138	90	91	11	6	459	81	74
Springfield	8	0	1		0	150	1	4
Michigan:								
Detroit	127	41	22	4	0	37	109	33
Flint	33	2	1	2	0	5	12	2
Grand Rapids	4	1	0		0	13	2	9

City reports for week ended April 18, 1931—Continued

Division, State, and city	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
		Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
EAST NORTH CENTRAL—continued								
Wisconsin:								
Kenosha	8	0	0		0	1	107	0
Madison	31	0	6			9	73	
Milwaukee	151	11	2	1	1	102	780	11
Racine	13	2	0		0	7	9	0
Superior	16	0	0		0	0	0	3
WEST NORTH CENTRAL								
Minnesota:								
Duluth	9	0	0		1	0	0	1
Minneapolis	106	11	0		5	43	220	11
St. Paul	63	7	1	2	2	24	4	7
Iowa:								
Des Moines	9	1	0			0	0	
Sioux City	18	1	0			2	10	
Waterloo	5	0	0			0	0	
Missouri:								
Kansas City	34	3	3		0	180	2	19
St. Joseph	3	0	1		0	7	0	13
St. Louis	16	34	23	6	1	43	25	19
North Dakota:								
Fargo	5	0	0		0	0	10	0
Grand Forks	0	0	0			0	0	
South Dakota:								
Aberdeen	7	1	1			4	0	
Sioux Falls	0	0	0			1	0	
Nebraska:								
Omaha	30	2	3		0	1	51	10
Kansas:								
Topeka	4	1	0	1	1	3	45	3
Wichita	4	1	2		0	5	1	0
SOUTH ATLANTIC								
Delaware:								
Wilmington	3	2	0		0	70	3	3
Maryland:								
Baltimore	89	22	12	3	1	1,195	28	29
Cumberland	1	0	0		0	1	0	0
Frederick	1	0	0		0	6	0	1
District of Columbia:								
Washington	33	11	17	4	3	287	0	18
Virginia:								
Lynchburg	29	1	0		0	2	0	1
Norfolk	10	1	1	1	0	344	10	2
Richmond	1	2	2		1	315	0	3
Roanoke	1	0	0		0	9	3	1
West Virginia:								
Charleston	0	0	0	1	0	1	0	3
Wheeling	31	0	0		0	0	0	3
North Carolina:								
Raleigh	20	0	0		0	94	0	2
Wilmington	0	0	0		0	0	0	1
Winston-Salem	6	0	0	1	1	60	23	5
South Carolina:								
Charleston	0	0	0	37	0	12	0	9
Columbia	3	0	0		1	0	5	2
Greenville	1	0	2		0	0	0	0
Georgia:								
Atlanta	7	2	1	32	6	27	0	10
Brunswick	1	0	0		0	0	4	1
Savannah	3	0	0	4	3	0	13	3
Florida:								
Miami	9	2	1	2	0	12	0	0
Tampa	3	1	1		0	120	1	0
EAST SOUTH CENTRAL								
Kentucky:								
Covington	1	1	1		0	37	0	8
Tennessee:								
Memphis	31	3	0		4	118	1	20
Nashville	3	1	0		1	91	0	4

City reports for week ended April 18, 1931—Continued

Division, State, and city	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
		Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
EAST SOUTH CENTRAL—continued								
Alabama:								
Birmingham	4	1	2	9	6	26	0	9
Mobile	0	0	1		1	3	0	5
Montgomery	0	0	0	2		2	0	
WEST SOUTH CENTRAL								
Arkansas:								
Fort Smith	1	0	0			1	0	
Little Rock	2	0	1		1	1	0	7
Louisiana:								
New Orleans	16	9	9	3	4	1	0	11
Shreveport	1	0	0		0	0	6	2
Oklahoma:								
Muskogee	7	0	1	5		0	4	
Texas:								
Dallas	45	5	7	6	5	1	26	13
Fort Worth	8	2	0		3	1	0	5
Galveston	1	0	0		0	7	0	3
Houston	3	4	4		1	3	0	6
San Antonio	3	3	1		2	16	1	8
MOUNTAIN								
Montana:								
Billings	3	0	0		0	1	0	1
Great Falls	9	0	0		0	0	1	0
Helena	0	0	0		0	0	0	0
Missoula	1	0	0		0	0	1	0
Idaho:								
Boise	5	0	0		0	0	0	0
Colorado:								
Denver	56	9	2		1	18	29	9
Pueblo	0	1	0		0	85	1	0
New Mexico:								
Albuquerque	5	0	0		0	0	0	1
Arizona:								
Phoenix	1	0	1		0	1	0	4
Utah:								
Salt Lake City	12	3	0		1	2	6	0
Nevada:								
Reno	0	0	0		0	0	0	3
PACIFIC								
Washington:								
Seattle	61	2	1			4	42	
Spokane	17	2	0			7	0	
Tacoma	6	1	3		0	0	2	4
Oregon:								
Portland	23	7	1	8	1	15	13	9
Salem	1	0	0		0	8	23	0
California:								
Los Angeles	73	31	13	38	2	160	20	16
Sacramento	11	2	3	1	2	8	1	3
San Francisco	77	14	2	8	0	34	11	5

City reports for week ended April 18, 1931—Continued

Division, State, and city	Scarlet fever: Cases, estimated expectancy	Scarlet fever: Cases reported	Smallpox: Cases estimated expectancy	Smallpox: Cases reported	Smallpox: Deaths reported	Tuberculosis, deaths reported	Typhoid fever: Cases, estimated expectancy	Typhoid fever: Cases reported	Typhoid fever: Deaths reported	Whooping cough, cases reported	Deaths all causes
NEW ENGLAND											
Maine:											
Portland	3	5	0	0	0	3	0	0	0	7	34
New Hampshire:											
Concord	0	0	0	0	0	1	0	0	0	0	6
Manchester	2	3	0	0	0	3	0	0	0	0	12
Vermont:											
Barre	0	3	0	0	0	1	0	0	0	3	2
Burlington	0	0	0	0	0	0	0	0	0	0	17
Massachusetts:											
Boston	82	143	0	0	0	12	1	1	0	36	232
Fall River	3	10	0	0	0	0	1	0	0	7	22
Springfield	9	10	0	0	0	3	0	0	0	7	31
Worcester	8	18	0	0	0	4	1	0	0	1	58
Rhode Island:											
Pawtucket	1	9	0	0	0	0	0	0	0	0	21
Providence	12	34	0	0	0	0	0	0	0	7	75
Connecticut:											
Bridgeport	11	3	0	0	0	2	0	0	0	2	36
Hartford	5	7	0	0	0	4	0	0	0	4	54
New Haven	8	1	0	0	0	2	0	0	0	1	38
MIDDLE ATLANTIC											
New York:											
Buffalo	28	32	0	4	0	15	0	0	0	44	152
New York	320	468	0	0	0	111	9	8	2	156	1,686
Rochester	10	87	0	0	0	0	0	0	0	18	78
Syracuse	12	27	0	0	0	2	1	0	0	34	56
New Jersey:											
Camden	6	7	0	0	0	2	0	0	0	2	28
Newark	33	66	0	0	0	7	1	0	0	46	106
Trenton	4	6	0	0	0	1	0	1	0	0	49
Pennsylvania:											
Philadelphia	103	170	0	0	0	34	2	0	0	38	553
Pittsburgh	28	64	0	0	0	8	0	0	0	26	226
Reading	5	2	0	0	0	0	0	0	0	0	27
EAST NORTH CENTRAL											
Ohio:											
Cincinnati	18	31	2	0	0	16	1	0	1	10	169
Cleveland	37	70	0	0	0	11	1	0	0	8	225
Columbus	10	2	1	0	0	3	0	0	0	4	73
Toledo	14	7	0	4	0	5	0	0	0	13	69
Indiana:											
Fort Wayne	5	0	2	6	0	0	0	0	0	0	22
Indianapolis	9	57	7	21	0	3	0	0	0	56	--------
South Bend	5	1	0	4	0	0	0	0	0	10	15
Terre Haute	2	2	1	0	0	1	0	0	0	0	17
Illinois:											
Chicago	122	254	2	0	0	47	1	1	1	68	749
Springfield	2	7	1	0	0	1	0	0	0	0	22
Michigan:											
Detroit	110	152	1	0	0	25	0	1	0	89	297
Flint	12	14	1	0	0	2	0	0	0	11	26
Grand Rapids	10	9	0	0	0	1	0	1	0	19	42
Wisconsin:											
Kenosha	2	0	1	0	0	1	0	0	0	0	9
Madison	4	1	0	0	--------	--------	0	0	--------	2	--------
Milwaukee	27	25	0	0	0	4	0	1	0	24	107
Racine	4	5	0	0	0	1	0	0	0	13	16
Superior	3	1	0	0	0	0	0	0	0	1	10
WEST NORTH CENTRAL											
Minnesota:											
Duluth	7	3	0	0	0	2	0	0	0	1	24
Minneapolis	38	23	2	2	0	1	0	0	0	28	106
St. Paul	29	7	1	0	0	3	0	0	0	17	62

City reports for week ended April 18, 1931—Continued

Division, State, and city	Scarlet fever: Cases, estimated expectancy	Scarlet fever: Cases reported	Smallpox: Cases estimated expectancy	Smallpox: Cases reported	Smallpox: Deaths reported	Tuberculosis, deaths reported	Typhoid fever: Cases, estimated expectancy	Typhoid fever: Cases reported	Typhoid fever: Deaths reported	Whooping cough, cases reported	Deaths all causes
WEST NORTH CENTRAL—contd.											
Iowa:											
Des Moines	10	10	2	10			0	0		0	33
Sioux City	2	8	0	1			0	0		2	
Waterloo	2	1	0	1			0	0		1	
Missouri:											
Kansas City	22	1	1	0	0	8	0	0	0	12	115
St. Joseph	3	4	0	0	0	2	0	0	0	0	34
St. Louis	36	210	2	4	0	11	2	1	0	12	247
North Dakota:											
Fargo	1	2	0	0	0	0	0	0	0	2	9
Grand Forks	0	0	0	0			0	0		0	
South Dakota:											
Aberdeen	1	0	0	0			0	0		0	
Sioux Falls	2	2	1	0			0	0		0	
Nebraska:											
Omaha	3	6	4	11	0	3	0	1	0	8	46
Kansas:											
Topeka	3	3	0	1	0	0	0	0	0	10	21
Wichita	2	3	2	28	0	0	0	0	0	3	35
SOUTH ATLANTIC											
Delaware:											
Wilmington	5	12	0	0	0	1	0	0	0	1	28
Maryland:											
Baltimore	36	41	0	0	0	21	1	1	0	29	248
Cumberland	0	2	0	0	0	0	0	0	0	0	15
Frederick	1	0	0	0	0	0	0	0	0	0	4
District of Col.:											
Washington	25	27	1	0	0	11	0	0	0	10	149
Virginia:											
Lynchburg	0	2	0	0	0	1	0	1	0	0	15
Norfolk	1	5	0	0	0	1	0	0	0	3	
Richmond	2	7	0	0	0	7	0	0	0	1	70
Roanoke	2	1	0	0	0	1	0	0	0	0	13
West Virginia:											
Charleston	0	1	1	2	0	1	0	0	0	4	19
Wheeling	2	0	0	0	0	2	0	[1] 1	0	9	23
North Carolina:											
Raleigh	0	1	1	0	0	2	0	0	0	45	8
Wilmington	0	0	0	0	0	0	0	0	0	8	6
Winston-Salem	0	0	1	0	0	0	0	0	0	10	24
South Carolina:											
Charleston	0	1	0	0	0	5	0	0	0	0	39
Columbia	0	0	0	0	0	1	1	0	0	0	19
Greenville	0	0	0	0	0	0	0	0	0	0	
Georgia:											
Atlanta	4	58	2	3	0	2	0	0	0	0	74
Brunswick	0	0	0	0	0	0	0	0	0	0	4
Savannah	0	0	1	0	0	1	0	0	0	0	31
Florida:											
Miami	0	0	0	0	0	2	1	0	0	1	33
Tampa	1	2	0	0	0	1	1	1	0	5	13
EAST SOUTH CENTRAL											
Kentucky:											
Covington	2	14	1	0	0	1	0	0	0	0	27
Tennessee:											
Memphis	9	66	1	9	0	9	1	2	0	24	101
Nashville	2	10	2	0	0	4	0	0	0	0	46
Alabama:											
Birmingham	2	10	1	0	0	4	0	0	0	4	88
Mobile	0	0	0	0	0	3	0	0	0	0	38
Montgomery	0	0	0	0			0	0		0	

[1] Nonresident.

City reports for week ended April 18, 1931—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths all causes
	Cases, estimated expectancy	Cases reported	Cases estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
WEST SOUTH CENTRAL											
Arkansas:											
Fort Smith	0	0	0	0	--------	--------	0	0	--------	4	--------
Little Rock	1	5	0	0	0	7	0	0	0	0	--------
Louisiana:											
New Orleans	9	10	0	22	0	11	3	0	0	2	140
Shreveport	0	0	1	0	0	5	0	0	0	0	40
Oklahoma:											
Muskogee	1	0	2	0	--------	--------	0	0	--------	0	--------
Texas:											
Dallas	4	10	2	1	0	3	1	1	0	13	72
Fort Worth	2	2	5	4	0	1	0	0	0	0	35
Galveston	0	0	0	1	0	2	0	1	0	0	15
Houston	1	6	2	4	0	3	0	0	0	0	73
San Antonio	1	2	0	0	0	10	0	0	0	0	80
MOUNTAIN											
Montana:											
Billings	0	0	0	0	0	0	0	0	0	3	7
Great Falls	1	4	0	0	0	0	0	0	0	17	3
Helena	0	3	1	0	0	0	0	0	0	0	5
Missoula	1	0	0	0	0	0	0	0	0	0	4
Idaho:											
Boise	0	1	0	1	0	0	0	0	0	1	4
Colorado:											
Denver	12	22	0	0	0	7	0	0	0	34	82
Pueblo	2	0	0	0	0	1	0	1	0	4	8
New Mexico:											
Albuquerque	0	0	0	0	0	2	0	0	0	0	9
Arizona:											
Phoenix	1	1	0	0	0	2	0	0	0	0	--------
Utah:											
Salt Lake City	2	2	0	0	0	2	0	0	0	24	32
Nevada:											
Reno	0	0	0	0	0	0	0	0	0	0	6
PACIFIC											
Washington:											
Seattle	8	13	2	2	--------	--------	1	0	--------	89	--------
Spokane	6	0	7	8	--------	--------	0	0	--------	0	--------
Tacoma	2	1	4	0	0	1	0	0	0	8	31
Oregon:											
Portland	4	4	10	8	0	0	1	0	0	2	68
Salem	0	0	1	0	0	0	0	0	0	0	--------
California:											
Los Angeles	32	35	5	3	0	22	1	1	1	23	294
Sacramento	2	2	0	1	0	1	0	0	0	48	25
San Francisco	22	8	1	0	0	10	1	4	0	29	143

Division, State, and city	Meningococcus meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases estimated expectancy	Cases	Deaths
NEW ENGLAND									
Maine:									
Portland	0	0	1	0	0	0	0	0	0
Massachusetts:									
Boston	0	0	0	0	0	0	0	1	0
Worcester	1	0	0	0	0	0	0	0	0
MIDDLE ATLANTIC									
New York:									
New York	9	6	3	2	0	0	1	2	1
New Jersey:									
Newark	0	0	1	0	0	0	0	0	0
Pennsylvania:									
Philadelphia	5	4	1	0	0	0	0	1	0
Pittsburgh	1	2	1	3	0	0	0	0	0

City reports for week ended April 18, 1931—Continued

Division, State, and city	Meningococcus meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases estimated expectancy	Cases	Deaths
EAST NORTH CENTRAL									
Ohio:									
Cincinnati	0	0	0	1	0	0	0	0	0
Cleveland	2	1	1	0	0	0	0	0	0
Columbus	2	1	0	0	0	0	0	0	0
Indiana:									
Indianapolis	2	0	0	0	0	0	0	0	0
Illinois:									
Chicago	15	8	2	2	0	0	0	0	0
Michigan:									
Detroit	5	4	1	0	0	0	0	0	0
Wisconsin:									
Racine	0	0	1	1	0	0	0	0	0
WEST NORTH CENTRAL									
Missouri:									
St. Louis	3	1	0	0	0	0	0	0	0
Nebraska:									
Omaha	1	0	0	0	0	0	0	0	0
Kansas:									
Topeka	0	0	0	0	1	0	0	0	0
SOUTH ATLANTIC									
Maryland:									
Baltimore	4	2	0	0	0	0	0	1	0
District of Columbia:									
Washington	5	3	0	0	0	0	0	0	0
Virginia:									
Lynchburg	0	0	0	0	0	1	0	0	0
Roanoke	0	0	0	0	0	1	0	0	0
West Virginia:									
Charleston	1	1	0	0	0	0	0	0	0
North Carolina:									
Raleigh	0	0	0	0	1	0	0	0	0
Wilmington	0	0	0	0	1	0	0	0	0
Winston-Salem	0	0	0	0	1	0	0	0	0
South Carolina:									
Charleston	0	0	0	0	7	1	0	0	0
Columbia	1	0	0	0	0	0	0	0	0
Georgia:									
Atlanta	0	0	0	0	1	1	0	0	0
Brunswick	0	0	0	0	0	1	0	0	0
Savannah	0	0	0	0	1	0	0	0	0
EAST SOUTH CENTRAL									
Tennessee:									
Memphis	7	2	0	0	0	0	0	0	0
Nashville	1	1	0	0	0	0	0	0	0
Alabama:									
Birmingham	3	3	0	0	0	0	0	0	0
Mobile	2	0	0	0	0	0	0	0	0
Montgomery	0	0	0	0	1	0	0	0	0
WEST SOUTH CENTRAL									
Louisiana:									
New Orleans	1	0	0	0	0	0	0	0	0
Shreveport	0	0	0	0	0	1	0	0	0
Texas:									
Dallas	0	0	0	0	3	1	0	0	0
Fort Worth	0	0	0	0	0	1	0	0	0
MOUNTAIN									
Montana:									
Billings	1	0	0	0	0	0	0	0	0
Colorado:									
Pueblo	1	0	0	0	0	0	0	0	0
New Mexico:									
Albuquerque	0	0	0	0	0	0	0	1	0
Arizona:									
Phoenix	0	2	0	0	0	0	0	0	0
Utah:									
Salt Lake City	2	0	0	0	0	0	0	0	0
PACIFIC									
California:									
Los Angeles	2	0	0	0	1	0	0	4	0

The following tables give the rates per 100,000 population for 98 cities for the 5-week period ended April 18, 1931, compared with those for a like period ended April 19, 1930. The population figures used in computing the rates are estimated mid-year populations for 1930 and 1931, respectively, derived from the 1930 census. The 98 cities reporting cases have an estimated aggregate population of more than 33,000,000. The 91 cities reporting deaths have more than 31,500,000 estimated population.

Summary of weekly reports from cities, March 15 to April 18, 1931—Annual rates per 100,000 population, compared with rates for the corresponding period of 1930 [1]

DIPHTHERIA CASE RATES

	Week ended—									
	Mar. 21, 1931	Mar. 22, 1930	Mar. 28, 1931	Mar. 29, 1930	Apr. 4, 1931	Apr. 5, 1930	Apr. 11, 1931	Apr. 12, 1930	Apr. 18, 1931	Apr. 19, 1930
98 cities	65	97	78	82	53	79	65	93	66	86
New England	67	65	70	56	46	68	84	82	79	119
Middle Atlantic	64	97	63	80	48	74	59	92	62	83
East North Central	72	132	82	114	64	107	86	115	83	96
West North Central	73	74	163	64	42	52	63	89	63	87
South Atlantic	73	90	61	70	47	64	49	80	65	64
East South Central	23	36	76	48	29	30	17	6	23	18
West South Central	71	136	64	125	85	139	54	153	74	206
Mountain	17	88	87	44	44	26	35	79	17	9
Pacific	51	45	69	34	53	51	57	51	43	36

MEASLES CASE RATES

98 cities	1,040	776	1,208	879	1,122	1,004	1,326	1,195	1,316	1,227
New England	1,527	1,030	1,479	1,117	1,106	1,449	1,503	1,562	1,349	1,628
Middle Atlantic	1,158	539	1,321	611	1,250	789	1,422	966	1,543	1,097
East North Central	559	538	723	654	727	799	831	904	790	1,074
West North Cental	492	994	650	908	532	860	704	1,199	589	1,009
South Atlantic	3,442	617	3,879	697	3,808	867	4,546	1,067	4,343	1,089
East South Central	995	1,291	1,635	968	1,501	526	1,751	329	1,612	299
West South Central	51	547	47	784	88	731	68	721	101	502
Mountain	1,288	2,890	1,140	2,987	661	4,731	844	7,674	923	6,793
Pacific	394	1,800	519	2,184	358	2,008	499	2,059	417	1,800

SCARLET FEVER CASE RATES

98 cities	388	316	402	308	371	301	362	320	382	298
New England	676	372	697	363	577	462	474	351	584	402
Middle Atlant c	392	294	454	299	404	293	413	281	415	262
East North Central	395	418	378	383	378	377	338	430	383	391
West North Central	589	335	580	306	585	271	537	339	518	366
South Atlantic	342	286	310	272	290	276	355	308	306	302
East South Central	483	179	559	233	396	143	465	132	582	143
West South Central	101	108	78	111	95	157	105	108	112	115
Mountain	305	352	209	458	157	238	174	335	278	352
Pacific	110	202	104	204	92	168	104	217	116	144

SMALLPOX CASE RATES

98 cities	21	24	17	22	14	23	19	29	22	27
New England	0	0	0	2	0	0	0	2	0	2
Middle Atlantic	0	0	0	0	0	0	1	0	2	0
East North Central	8	20	7	17	9	30	6	23	19	23
West North Central	130	97	99	99	78	87	96	149	92	139
South Atlantic	0	2	4	8	2	2	18	10	10	4
East South Central	12	6	12	18	12	0	0	12	52	18
West South Central	95	49	78	45	71	17	81	28	95	70
Mountain	9	35	44	26	0	106	17	62	9	26
Pacific	43	103	22	71	16	71	53	89	27	71

[1] The figures given in this table are rates per 100,000 population, annual basis, and not the number of cases reported. Populations used are estimated as of July 1, 1931 and 1930, respectively.

***Summary of weekly reports from cities, March 15 to April 18, 1931—Annual rates per 100,000 population, compared with rates for the corresponding period of 1930*—Continued**

TYPHOID FEVER CASE RATES

	Week ended—									
	Mar. 21, 1931	Mar. 22, 1930	Mar. 28, 1931	Mar. 29, 1930	Apr. 4, 1931	Apr. 5, 1930	Apr. 11, 1931	Apr. 12, 1930	Apr. 18, 1931	Apr. 19, 1930
98 cities	4	8	4	8	4	4	5	5	5	6
New England	2	0	2	2	2	5	2	0	2	7
Middle Atlantic	2	6	2	15	3	3	5	1	4	2
East North Central	2	1	2	3	2	2	3	1	2	2
West North Central	8	10	2	4	4	2	0	4	4	8
South Atlantic	16	14	12	6	14	4	16	22	8	22
East South Central	0	84	0	30	0	30	6	18	12	6
West South Central	10	10	7	7	10	10	3	7	7	7
Mountain	0	18	0	0	9	18	0	44	9	18
Pacific	8	10	10	2	2	6	8	4	10	8

INFLUENZA DEATH RATES

	Mar. 21, 1931	Mar. 22, 1930	Mar. 28, 1931	Mar. 29, 1930	Apr. 4, 1931	Apr. 5, 1930	Apr. 11, 1931	Apr. 12, 1930	Apr. 18, 1931	Apr. 19, 1930
91 cities	32	15	29	14	23	13	18	16	17	15
New England	19	2	14	10	2	7	19	7	7	7
Middle Atlantic	23	14	20	10	17	14	12	20	12	14
East North Central	28	9	25	11	18	10	14	8	10	12
West North Central	47	12	35	6	12	9	15	9	29	18
South Atlantic	49	28	32	16	39	8	30	26	32	22
East South Central	113	78	126	97	126	39	60	45	76	58
West South Central	35	25	55	32	69	36	45	25	45	25
Mountain	35	62	61	53	26	26	17	26	17	9
Pacific	34	7	41	2	14	0	19	12	10	2

PNEUMONIA DEATH RATES

	Mar. 21, 1931	Mar. 22, 1930	Mar. 28, 1931	Mar. 29, 1930	Apr. 4, 1931	Apr. 5, 1930	Apr. 11, 1931	Apr. 12, 1930	Apr. 18, 1931	Apr. 19, 1930
91 cities	184	161	180	163	171	161	155	164	161	149
New England	183	218	156	220	127	181	173	186	144	160
Middle Atlantic	216	159	220	187	223	184	168	185	180	180
East North Central	132	148	125	117	120	146	118	127	128	114
West North Central	215	123	171	135	150	117	253	150	244	156
South Atlantic	269	222	263	212	221	196	199	230	188	202
East South Central	208	188	189	227	170	155	176	201	290	207
West South Central	180	199	211	164	238	164	169	181	173	121
Mountain	122	194	131	176	157	185	191	185	113	167
Pacific	101	77	98	92	53	62	60	72	67	37

FOREIGN AND INSULAR

SMALLPOX ON VESSEL

Information has been received stating that the S. S. *Benvenue* arrived in Sydney, Australia, on January 14, 1931, with a case of smallpox on board. It was thought that the infection occurred in Shanghai, which was the vessel's previous port of call. The patient was placed in quarantine, the crew vaccinated, and the necessary disinfection of the ship carried out. No further cases occurred.

AUSTRALIA

Notifiable diseases—52 weeks ended December 27, 1930.—The following table gives the provisional figures for cases of notifiable infectious diseases reported in Australia during the 52 weeks ended December 27, 1930.

Disease	New South Wales	Victoria	Queensland	South Australia	West Australia	Tasmania	Federated Capital Territory
Cerebrospinal fever	43	17	3	8	2	2	----------
Diphtheria	4,043	3,225	1,807	244	1,032	570	9
Dysentery	(1)	44	5	52	26	(1)	----------
Erysipelas	(1)	(1)	119	227	1	(1)	----------
Leprosy	5	----------	2	----------	----------	----------	----------
Lethargic encephalitis	11	12	2	7	----------	1	----------
Malaria	(1)	----------	9	----------	8	1	----------
Poliomyelitis	30	86	5	15	4	129	1
Puerperal fever	263	48	41	75	18	26	1
Scarlet fever	4,394	1,985	615	104	294	476	49
Tuberculosis	1,804	1,237	339	427	547	202	2
Typhoid fever	407	140	139	79	118	26	----------
Typhus, endemic	(1)	(1)	(1)	7	50	(1)	----------

[1] Not notifiable.

CANADA

Provinces—Communicable diseases—Weeks ended April 11 and 18, 1931.—The Department of Pensions and National Health of Canada reports cases of certain communicable diseases for the weeks ended April 11 and 18, 1931, as follows:

WEEK ENDED APRIL 11, 1931

Province	Cerebrospinal fever	Influenza	Lethargic encephalitis	Smallpox	Typhoid fever
Prince Edward Island [1]	----------	----------	----------	----------	----------
Nova Scotia	----------	25	----------	----------	----------
New Brunswick [1]	----------	----------	----------	----------	----------
Quebec	1	2	----------	----------	13
Ontario	3	52	----------	4	3
Manitoba	----------	----------	1	----------	3
Saskatchewan	----------	----------	----------	5	----------
Alberta [1]	----------	----------	----------	----------	----------
British Columbia [1]	----------	----------	----------	----------	----------
Total	4	79	1	9	19

[1] No case of any disease included in the table was reported during the week.

WEEK ENDED APRIL 18, 1931

Province	Cerebro-spinal fever	Influenza	Lethargic encephalitis	Smallpox	Typhoid fever
Prince Edward Island [1]					
Nova Scotia	3	2			
New Brunswick	1				1
Quebec					19
Ontario	1	1			7
Manitoba					1
Saskatchewan				16	1
Alberta	1				
British Columbia	1	11			
Total	7	14		16	29

[1] No case of any disease included in the table was reported during the week.

Quebec Province—Communicable diseases—Week ended April 18, 1931.—The Bureau of Health of the Province of Quebec, Canada, reports cases of certain communicable diseases for the week ended April 18, 1931, as follows:

Disease	Cases	Disease	Cases
Chicken pox	101	Puerperal septicemia	1
Diphtheria	27	Scarlet fever	85
German measles	10	Tuberculosis	67
Influenza	7	Typhoid fever	19
Measles	509	Whooping cough	75
Mumps	20		

Quebec Province—Vital statistics—February, 1931.—Births, deaths, and marriages for the month of February, 1931, in the Province of Quebec, Canada, with deaths from certain specified causes, are shown in the following table:

Estimated population	2,782,500	Deaths from—Continued.	
Births	5,951	Measles	14
Birth rate per 1,000 population	27.9	Nephritis	167
Deaths	2,990	Pneumonia	385
Death rate per 1,000 population	14.0	Poliomyelitis	2
Marriages	939	Puerperal state	31
Deaths under 1 year	786	Scarlet fever	14
Deaths under 1 year per 1,000 births	132.1	Syphilis	17
Deaths from—		Traffic	10
Cancer	188	Tuberculosis (pulmonary)	211
Diabetes	22	Tuberculosis (all other forms)	60
Diarrhea	113	Typhoid fever	12
Diphtheria	32	Violence	53
Heart disease	315	Whooping cough	42
Influenza	242		

CHINA

Meningitis.—During the week ended April 4, 1931, 17 deaths from cerebrospinal meningitis were reported in Shanghai, China. During the week ended April 11, 1 case of meningitis was reported in Hong Kong, and 5 cases in Canton.

COLOMBIA

Influenza—Bogota.—According to a report dated April 9, 1931, there was a widespread influenza epidemic in Bogota, Colombia. Few deaths had occurred. A large proportion of the population of the city was said to be affected.

YUGOSLAVIA

Communicable diseases—March, 1931.—During the month of March, 1931, certain communicable diseases were reported in Yugoslavia, as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax	19	3	Paratyphoid fever	2	
Cerebrospinal meningitis	23	13	Puerperal sepsis	4	3
Diphtheria and croup	609	77	Rabies	1	1
Dysentery	23	8	Scarlet fever	529	86
Erysipelas	179	7	Tetanus	12	3
Lethargic encephalitis	1	1	Typhoid fever	109	19
Measles	1, 545	34	Typhus fever	10	1

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

From medical officers of the Public Health Service, American consuls, International Office of Public Hygiene, Pan American Sanitary Bureau, health section of the League of Nations, and other sources. The reports contained in the following tables must not be considered as complete or final as regards either the list of countries included or the figures for the particular countries for which reports are given.

CHOLERA

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931			February, 1931				March, 1931				April, 1931			
					17	24	31	7	14	21	28	7	14	21	28	4	11	18	25
Ceylon: Colombo	C												1						
China:																			
Canton	C	1															1		
Shanghai	C	2																	
India	C	18,944	11,112	10,687	3,504	4,022	4,275	3,533	3,529	2,549									
	D	9,782	5,933	5,689	1,770	2,165	2,231	1,957	1,846	1,325									
Bombay	C	19	13		20	1											2		
	D	17	7		6	3											1		
Calcutta	C	33	22	28	36	29	24	32	27	33	45	65	80	102	129	125	95		
	D	16	16	20	25	19	19	23	22	25	26	39	49	68	69	70	55		
Karikal	C			1					4		1	4	2	1	7	2			
	D								4			4	2	1	7	2			
Madras	C	1		201	47	36	16		18	20	19	15	4	5	7	4			
	D			67	21	11	7	8	5	4	14	6	5	3	2				
Negapatam	D						1	2	1		2								
Rangoon	C			1															
	D			1	1														
Tuticorin	C	1	5	1	1					1									
	D	1																	
India (French):																			
Chandernagor	C	1	1	2			1			1	2	2	2	2	2				
	D			3			1			1	3	1	2	3	1				
Pondicherry	C	1	4	31	9	4	3	3	10	20	31	39	29	25	26	20	5		
	D		4	21	3	3	3	2	10	9	6	9	6	5	4	3	1		
India (Portuguese)	C	14		1															
	D	9																	
Indo-China (see also table below):																			
Pnompenh	C	1	2			1	2	1		3	3	3					1		
	D		2				2			1	2	2		1					
Saigon and Cholon	C	1	3	9	4	1		1			3	1	1		1	3	2		
	D		1	4	2	1					3	1	2	1	1	1			

Philippine Islands:[1]																			
Ports—Iloilo	C		1	1			2												
	D		3	1			2												
Provinces—																			
Capiz	C						8	56	69	54	28	35	29	11	4	4		3	8
	D						2	45	55	39	23	29	24	10	4	3		3	8
Iloilo	C	30	45	28	11	41	36	57	27	42	10	16	2	5					
	D	23	27	22	9	27	25	49	21	22	11	11	2	2					
Masbate	C												21						
	D												9						
Negros, Occidental	C	56	163	120	19	32	38	6	1	1	2								
	D	41	123	97	15	17	19	5	1	1	2								
Negros, Oriental	C							1											
	D							1											
Samar	C	16	8	17															
	D	12	8	9															
Sorsogon	C	5																	
	D	4																	
Siam	C	4	6	2	2		1			1				4	4	2			
	D	4	6	2	1									1	1				
Ayudhaya District	C															1			
Bangkok	C	3	4	2	2		1		1			1		1	1		1		
	D	2	4	2	1							1		1	1				
Bismulok Province	C													4	4				
	D													1	1				

[1] Figures for cholera in the Philippine Islands are subject to correction.

Place		September, 1930	October, 1930	November, 1930	December, 1930			January, 1931			February, 1931			March, 1931		
					1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-28	1-10	11-20	21-31
Indo-China (French) (see also table above):																
Cambodia[1]	C	38	22	26	28			7	19	36		35				65
Cochin-China[1]	C	33	28	13	8			7	4	13		5				33

[1] Reports incomplete.

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

PLAGUE

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931: 17	24	31	February, 1931: 7	14	21	28	March, 1931: 7	14	21	28	April, 1931: 4	11	18
Algeria:																		
Algiers	C	11	2	1	1		1		1							1		
	D	3														1		
Bone	C						1											
Constantine, vicinity of	C	1		50			1		1									
	D						1											
Oran	C	2																
	D	1																
Plague-infected rats		1																
Philippeville	C	2		1														
	D			1														
Argentina:																		
Cordoba Province	C					1				2								
Entre Rios Province—Diamante	C										2							
Jujuy Province—Palpala	C						1			1								
Santa Fe	C									2								
Belgian Congo	C	1	1											2				
	D	1	1											2				
British East Africa (see also table below):																		
Tanganyika	C		3	2							15	7						
	D		3	2							4							
Uganda	C	171	111	67	7	8	2	8	6	4								
	D	168	112	67	6	8	2	8	6	4								
Ceylon: Colombo	C	1	9	9	1	1	1	5	6	2	1	2	1	3	3	1	1	
	D	1	8	9		1	1	4	7	2	1	3	1	3	2	1	1	
Plague-infected rats		1	2				1	1	1	1	1			3	1			
China: Shensi	C	1																
Dutch East Indies:																		
Batavia and West Java	C	143	208	239	56	57	37	30	29	36	46	30	18					
	D	146	206	238	54	53	37	24	29	35	46	23	17					
East Java and Madura	C							4			1							
	D							4			1							
Java and Madura	D	501	557	615	142	102	98	85	89	100	99	80	65	81				

Egypt:																		
Alexandria	C	7	4	8				1	1			1	1					
	D	7	1															
Plague-infected rats			3	1		1				1								
Assiout	C	3	9	7	2	19	2	3	9		17	15	6	10	1	1	5	16
	D	1	1	1	2	2	2		4		8	4		4	1	1		11
Aswan	C		3															
Beni-Suef	C				1													
	D				1													
Cairo	C															1		
Deirout	C					19	2		6	10								
	D					2	2			4								
Gharbieh	C						1											
	D						1											
Girga	C			7				1						14	37	35	31	9
	D			2				1						2	5	17	13	8
Kena	C														5			
	D														2			
Manfalut	C			23	5	21	4		11		2	2	3	5	9			
	D			5	2	3	1		4		1			2	1			
Minieh	C		1			1	1							2	1			
	D						1							1	1			
Port Said	C	2																
France: Marseille	C	4																
Greece (see table below).																		
India	C	2,721	3,259	3,740	1,169	1,279	1,438	1,449	1,270	1,095								
	D	1,497	1,856	2,226	837	737	957	891	862	774								
Bassein	C	1		2	1		1	2				1						
	D			1	1			2	1									
Bombay	C	1				1			1				1	1	1	1	4	
	D	1				1			1					2	1		4	
Plague-infected rats		30	32	38	10	6	9	9	14		8	10	17	14	21	18	34	
Madras Presidency	C	185	148	220	73	99	75	65	30	19	13	12						
	D	124	78	154	47	53	39	43	17	18	7	4						
Rangoon	C	2		2		2									1		1	
	D	1		1		1									1		1	
Plague-infected rats		1	4	2	2	1	1			8						1	1	
India (Portuguese)	C	3																
	D	3																
Indo-China (see also table below): Pnompenh	C		6	1	1	3	2	1				1						
	D	1	6	1	1	3	2	1		1	2	1	2	1	1	2	2	
Iraq: Baghdad	C	P	4			2	3				1	2	1	3	3	1		5
	I		2			2	2					2		3	1	1		2
Madagascar (see also table below): Tamatave	C	5	4	2		5	4											
	I	3	3															
Morocco	C	5		19	13													
	I			8	4													
Nigeria: Lagos	C	38	9	5				1									2	
	I	5	9	5				1									2	
Plague-infected rats		13	5	5														
Peru (see table below).																		
Senegal (see table below).																		

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

PLAGUE—Continued

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931: 17	24	31	February, 1931: 7	14	21	28	March, 1931: 7	14	21	28	April, 1931: 4	11	18
Siam	C	6						4	5	9	3	1	2	2				
	D	5						2	4	6	4		1	1				
Bangkok	C	1	1	3		4	4		1	2	3		29					
	D	1	1	3		4	3	1		1	4		6					
Nagara Rajsima	C	1	11	17	3	2	1	3	7						1			
	D	1	9	10	2	3	1	4	6									
Syria: Beirut	C	6		1				1		1								
Tripolitania	C	1	13		2	2	1	3		1			1					
	D		1		2			1										
Tunisia: Tunis	C	1	P	13	1					0	2	3		5		5	5	
	D									7						4	4	
Union of Socialist Soviet Republics:																		
Gouranduz	D						28											
Transcaucasia—Karabakh	C					6												
Union of South Africa:																		
Cape Province	C	1	P															
Orange Free State	C			2				P	P	1	P		2					
	D			2						1								
On vessel: S. S. Marionga de Thermiotis at Avonmouth	C			1														

Place		Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930	Jan., 1931
British East Africa (see also table above):							
Kenya	C	87	53	58	62	50	69
Greece	C			2			
Indo-China (see also table above)	C	2	5	2	5	1	
Madagascar (see also table above):							
Ambositra Province	C			4	44	95	100
	D			4	44	87	96
Antisirabe Province	C	11	21	3	18	27	66
	D	11	21	3	18	26	57

Place		Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930	Jan., 1931
Peru	C	21	10	42	34	8	
	D	8	2	20	14		
Senegal:							
Baol [1]	C	79	48	53			
	D	20	23	35	4		
Dakar [1]	C	108	3				
	D	90	8				
Louga [1]	C	75	61	37	10		
	D	33	30	25	3		

Miarinarivo Province	C	2	7	18	12	18	28	Thies [1]	C	34	12	24	27	2	
	D	2	7	18	12	18	26		D	20	4	15	23	1	
Moramanga Province	C	27	18	20	19	13	7	Tivaouane [1]	C	110	20	53	31	2	
	D	27	17	20	19	11	5		D	54	14	31	25	1	
Tananarive Province	C	89	79	125	170	178	92								
	D	88	79	116	164	172	89								

[1] Reports incomplete.

SMALLPOX

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931			February, 1931				March, 1931				April, 1931		
					17	24	31	7	14	21	28	7	14	21	28	4	11	18
Algeria:																		
Algiers	C			1				1		1					2			
Bone	C						1											
Constantine	C	1												1				
Oran	C		3															
Arabia: Aden	C							1	1									
Belgian Congo	C			79	27	23												
Belgium	C								1									
Brazil:																		
Porto Alegre (alastrim)	C	28	36			3			1	1	2	3	7					
Rio de Janeiro	C	2																
British East Africa (see also table below): Tanganyika	C	17	385	84	21	25	18	6	35	42	13	1						
	D	1	36	4	1	1	2	1		12	1							
British South Africa: Southern Rhodesia	C	95	18	18	2	1												
	D		3															
Canada:																		
Alberta	C		1	19		7			1									
British Columbia—Vancouver	C	3	1	3				2	1	2	5							
Manitoba	C						1				1							
Winnipeg	C			1							1							
Nova Scotia	C						1								1			
Ontario	C	59	23	17	10	3	32	4	10	4	7	8	2	3	3	1	4	
Kingston	C			6	1					1								
North Bay	C			2					1									
Ottawa	C	37	12	2	1	1	1			1								
Sault Ste. Marie	C			1	11	8	5	6			2						3	1
Toronto	C		4										1		1		3	
Quebec	C		2			2												
Saskatchewan	C	2	18		7	6	5	20	17	18	18	10	40	10	8		5	16
Regina	C									1					2			

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

SMALLPOX—Continued

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931			February, 1931				March, 1931				April, 1931		
					17	24	31	7	14	21	23	7	14	21	28	4	11	18
Canary Islands: Las Palmas	C														1			
China:																		
Canton	C								2			1	1	2	2	2	1	
Chungking	C	P	P	2														
Foochow	C	P	P	P		P		P		P		P		P				
Hong Kong	C			1		1			2	5		2			1	1		
	D								1	1	1				2			
Manchuria—																		
Harbin	C	1					1				1							
Kwantung—Dairen	C		4	1											2			
	D		1															
Nanking	C	P	P	P	P		P	P	P	P	P	P		P	P			
Shanghai—																		
Foreigners only	C	2	8	14	1	1	6	4	4	7	2	3	3	1	1	1	2	
Including natives	D	1	4	11	2	4	4	3	5	2	4	3	5	2	2	1	2	
Swatow	D	3	3	5	1	1	3	2		3	3	7	3	6	9	8	8	
Tientsin	C	1	2		1													
Chosen (see table below).																		
Colombia: Cali	D		1															
Dutch East Indies:																		
Java—Batavia and West Java	C	26	6	4		28		1		2			1					
	D	4	2	2		1		1	1									
Sanggi Islands	C	29																
	D	3																
France (see table below).																		
Great Britain:																		
England and Wales	C	372	508	665	187	272	286	213	221	50	247	227	171	219	226	179		
Bradford	C	1	1	1		1		3		1				1				
Leeds	C	2		2												1		
London	C	172	184	161	45	47	33	24	23	16	23	36	26	54	32	35		
London and Great Towns	C	296	433	560	154	198	194	147	150	186	189	158	117	154	166	117		
	D	1	1							1								
Sheffield	C					1	1	1		16	6	10	2	1	6	1		
Stoke-on-Trent	C	1				1						1						

Greece (see table below).																		
Honduras:																		
Amapala	C											1						
Ocotopeque and Gracias districts	C											P						
Puerto Castilla	C			4	7	1		3	3									
Tela	C																1	
India	C	2,412	3,627	5,623	2,068	2,396	2,477	2,682	2,996	2,766								
	D	606	874	1,381	497	486	523	739	665	620								
Bombay	C		1	2	2	2	2	1		1	3	2	4	1	4	1	2	
	D		1	2			1			1	1	1		1	2	1	1	
Calcutta	C	9	18	59	28	28	40	47	35	51	83	82	53	69	75	86	101	
	D	7	11	40	16	22	29	33	26	41	66	55	36	54	50	63	78	
Cochin	C	25	22	15	5	6	8	10	19		16	24	15	17	14		10	
	D	3	4	1					1		1	1						
Karachi	C		3				2	1			4			3				
	D		1				1	1							2			
Madras	C	9	20	4	4	7	3	2	4	1	3	1	6	3	9	4	12	
	D	2	3							1				2	1		2	
Moulmein	C					2												
Negapatam	C	9	6														1	
Rangoon	C	1	1						2		1	1	1	1	1		2	
	D	1											1					
Vizagapatam	C							1			8		1		1		2	
	D										2				1		1	
India (French):																		
Chandernagor	C	3		5	3	2	1	3	2		6	6	3	3	6	2		
	D	1		3	1						1					2		
Karikal	C			3	1	2		2	2		16	1			1			
	D			2		2		2	2		16							
Pondicherry Province	C	11	19	34	16	8	13	8	1	1	10	7	7		4		3	
	D	11	17	32	16	8	13	8	1	1	10	7	7		4		3	
India (Portuguese)	C			4	1	4			2	3	6	3						
	D								2		1							
Indo-China (see also table below):																		
Pnompenh	C		1	2				1					1					
	D		1					1										
Saigon and Cholon	C	2	2		3	1		2		2	2		4	1	1		1	
	D	2	2		2			2			1		3	1	2	2	1	
Iraq:																		
Baghdad	C										3	6						
Mosul Liwa	C	6	16	1		2		1		5								
	D		2							1								
Ivory Coast (see table below).																		
Japan:																		
Kobe	C										1	1						
Taiwan	C							1										
Mexico (see also table below):																		
Jalisco (State)—Guadalajara	D	3	3			1									1			
Juarez	D	1																
Mexico City and surrounding territory	C	9	6	10					7	5		11	13	13	7		17	
	D	2	6	6				1	1	3	2	2	5	5	6	6	4	
Vera Cruz	C	1							1		1	1		1	1			1

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

SMALLPOX—Continued

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931: 17	24	31	February, 1931: 7	14	21	28	March, 1931: 7	14	21	28	April, 1931: 4	11	18
Morocco (see table below).																		
Nicaragua: Porto Cabezas	C			2														
Nigeria: Lagos	C														2			
Panama Canal Zone	C						2											
Poland	C	8	3	25						1								
Portugal: Lisbon	C	20	37	72	27	31	15	30		12	10	9	16	15	17	4	8	
Siam	C			1	1	1	1	1	1	1								
Somaliland, British: Boales	C	1	1															
	D			1														
Spain	C	51	67	68			10	8	10	4	10	46	45	15	21	22		
Straits Settlements	C	10	17	6	3	1	2	1			2				2	1	1	
	D	2	7	3			1				1				1		1	
Sudan (Anglo-Egyptian)	C	5	50	64	1	7		3	1	1	44	51	3	1	4			
	D	1	5	6		7					6	4		1	1			
Sudan (French) (see table below).																		
Syria (see table below).																		
Tunisia: Tunis	C			17	6	1	1								4			
Turkey (see table below).																		
Union of South Africa:																		
Cape Province	C	P	P	P				P				P						
Orange Free State	C	2	P					P			P	P			P			
Transvaal	C	P	P	P	P	P	P	P	P	P	P	P	P					
Upper Volta	C		6	4						8	10				3			
	D			2											1			
On vessel:																		
S. S. Clan Mactoggart at Suez	C								2									
S. S. Muncaster Castle at Manila from Hong Kong	C			1														
S. S. Matheran at Suez from Calcutta	C					1												
S. S. Clan Buchanan at Suez	C										2							
S. S. Rotterdam at Naples from Venice	C														1			
S. S. Clan McTavish at Manila from Chittagong	C																	1
S. S. Benvenne at Sydney from Shanghai	C				1													

Place		September, 1930	October, 1930	November, 1930	December, 1930			January, 1931			February, 1931			March, 1931		
					1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-28	1-10	11-20	21-31
Indo-China (see also table above)	C	192	258	86	38	9	14		48	46		46				139
Ivory Coast	C		4	2	9											
Sudan (French)	C	P	17		43		96							4		P
	D		2		16		4									
Syria: Beirut	C								1							

Place		July, 1930	Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930
British East Africa (see also table above):							
Kenya	C	186		424		653	
Chosen	C	65	35	3	22		
	D	21	15	5	6		
France	C	1					
Greece	C	1	6				4
Mexico (see also table above)	D	659	718	822	893		1
Morocco	C	3	8	4	4	20	25
Turkey	C	51	21	19	74	65	116
	D	13	4	2	1	1	9

TYPHUS FEVER

[C indicates cases; D, deaths; P, present]

Place		Oct. 19-Nov. 15, 1930	Nov. 16-Dec. 13, 1930	Dec. 14, 1930-Jan. 10, 1931	Week ended—													
					January, 1931			February, 1931				March, 1931				April, 1931		
					17	24	31	7	14	21	28	7	14	21	28	4	11	18
Algeria:																		
Algiers	C	1	2						1	1					3			
Constantine Department	C	1	2	6		6	6	19			4			1		2	2	
Oran	C		5			1	2					1						
Australia; western	C															1		
Bulgaria	C	3	11	3	9	2	1	1		2		3				9		
	D			1												2		
Chile: Valparaiso	D													1				
China:																		
Canton	C					2							1					
Manchuria—Harbin (see also table below)	C		1			3												
Shanghai	C					2												
Tientsin	C		1															

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

TYPHUS FEVER

[C indicates cases; D, deaths; P, present]

Place		Oct. 19–Nov. 15, 1930	Nov. 16–Dec. 13, 1930	Dec. 14, 1930–Jan. 10, 1931	Week ended— January, 1931 17	24	31	February, 1931 7	14	21	28	March, 1931 7	14	21	28	April, 1931 4	11	18
Chosen (see table below).																		
Czechoslovakia (see table below).																		
Egypt:																		
Alexandria	C	2	2															1
	D	2																
Beheira Province	C			1													3	
	D			1													2	
Cairo	C		1	1				1										
Port Said	C	2				1												
Eritrea: Asmara	C												1					
Great Britain: Scotland	C							1										
Glasgow	C						2											
	D						1											
Greece (see table below).																		
Guatemala.[1]																		
Iraq: Baghdad	C								2	1	1	1	1					
	D								1									
Latvia (see table below).																		
Lithuania (see table below).																		
Mexico (see also table below):																		
Durango	D						1										1	
Mexico City, including municipalities in Federal District	C	11	14	12	13	12	6	8	13	13	9		46	66	73	31	67	
	D	4	7	10	8	9	9	8	4	7	5		20	13	31	20	18	
San Luis Potosi	D		2						2	2		1	1	1	2		1	2
Morocco	C	3	1	8			6	2	7	8	5	8	2	2	3			
	D					2				1								
Palestine	C	3	7	4	1	1			3				2	1	1	1	1	
Paraguay: Asuncion	D					2	2											
Poland	C	37	42	63	19	21	16	50	49	41	43	56	62	58	85	82	93	
	D		7	3	2	1	4	1	3	3	4	9	4		7	4	8	
Portugal: Oporto	C	4	6			1												
Rumania	C	41	34	113	54	43	51	45	49	53	12	38	55					
	D	2	8	5	1	7	6	2	5	11	3	5	4					
Spain	C	4	1															
	D		1															

Place																		
Tunisia:																		
Sbeitla, vicinity of	C															20		
	D															7		
Sfax	C														2			
Tunis	C		28			7	4	5			6	12	5	2	7		2	
Turkey (see table below).																		
Union of South Africa:																		
Cape Province	C	P	P	P	P	P	P	P	P	P	P	P	1					
Municipality of East London	C	1	1	3		1	1	1										
Natal	C	P		P	P	P	P	P	P	P				1				
Orange Free State	C	P		P	P	P	P	P	P		P	P	P					
Transvaal	C	P	P	P	P	P	P	P	P	P	P	P	P					
Yugoslavia (see table below).																		

[1] On Feb. 27, 1931, the Director General of Public Health of Guatemala reports an unusual outbreak of typhus fever in a small village in Guatemala.

Place		Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930	Jan., 1931	Feb., 1931
China: Harbin (see also table above)	C		3				
Chosen: Seoul	C	1	7	1	1	1	
Czechoslovakia	C			16	24	60	
Greece	C	4	4	4	10	10	17
Latvia	C	2					
Lithuania	C	24	1	5	6	26	8
	D	2		1	3	3	1
Mexico (see also table above)	D	47	47				
Turkey	C		28	3	2		18
Yugoslavia	C		2	2		20	
	D		1			2	

YELLOW FEVER

	Cases	Deaths
Brazil:		
Bahia State—		
Mar. 14, 1931	1	
Mar. 15-21, 1931	1	
Ceara State—Mar. 14, 1931	2	
Barbalha, Feb. 7, 1931	1	1
Minas Geraes State—		
Mar. 20, 1931	2	
Apr. 5-11, 1931	1	
Rio de Janeiro State—		
Mar. 7, 1931	1	1
Mar. 14, 1931	1	1
Mar. 21, 1931	1	1
Brazil—Continued.		
Rio de Janeiro State—Continued.		
Cambucy—	3	3
Jan. 1-25, 1931	1	1
Feb. 1-7, 1931	1	
Friburgo (imported), Jan. 25-30, 1931		
Padua—	1	1
Jan. 18-24, 1931	1	1
Feb. 1-7, 1931	1	
Feb. 8-14, 1931		

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