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THE PREVALENCE OF INFLUENZA

United States.—The reports to the Public Health Service of cases of influenza for the week ended February 7, 1931, totaled 10,068, as compared with 12,828 cases for the preceding week. The figures, presented by geographical sections and States, appear on pages 433 and 434.

New York City, Maryland, and North Carolina, where the disease has been prevalent, reported fewer cases for the week ended February 7 than were reported for the preceding week. South Carolina showed a slight increase in prevalence. Massachusetts and Illinois reported decreased prevalence of influenza for the week ended February 7 as compared with the preceding week.

Maine and New Hampshire in the northeast and Georgia and Florida in the southeast reported increased prevalence, and there is some increase in California.

The disease is of mild type.

Europe.—Influenza is reported from a number of countries in Europe, but it is mild and there has not been any extensive epidemic. A report dated January 31, 1931, stated that in England and Wales influenza was reported in a number of cities, particularly in Liverpool. The mildness of the disease is indicated by the fact that most of the deaths attributed to influenza were of persons over 60 years of age.

In Switzerland outbreaks occurred in 17 districts. Basel and Zurich were chiefly affected. The general mortality in towns of more than 10,000 population for the weeks ended January 10 and January 17, 1931, was 14.5 and 15 per thousand, respectively. These rates are said to be low for this season of the year. In December the general mortality in these towns averaged only 12.6 per thousand.

In Spain influenza of a mild type prevailed, particularly in the cities of Madrid and Barcelona. The general mortality in these cities was somewhat higher than it had been during the corresponding period of recent years without epidemics, but it was lower than in January, 1927 or 1929.

In Czechoslovakia influenza has been reported in Bratislava and in some districts of Slovakia. The disease has appeared in Austria and in Greece, especially in Athens.

In Germany returns from sickness insurance organizations indicated that the epidemic reached its climax in the cities affected without causing any noticeable increase in mortality. In Poland the epidemic was said to be abating the latter part of January.

CURRENT PREVALENCE OF COMMUNICABLE DISEASES IN THE UNITED STATES[1]

DECEMBER 28, 1930–JANUARY 31, 1931

The prevalence of certain important communicable diseases, as indicated by weekly telegraphic reports from State health departments to the Public Health Service is summarized below. The underlying statistical data are published weekly in the Public Health Reports under the section entitled "Prevalence of Disease."

Influenza.—There was a sharp increase in influenza cases from 4,660 cases during the 4-week period ended December 27, 1930, to 26,924 [2] cases during the 4-week period ended January 31, 1931. Stated otherwise, during the December period the number of cases amounted to about 65 per cent of the number for the corresponding period of the preceding year; for the January period this percentage had risen to 263.

The tendencies in the different regions of the United States, as shown by reports to the Public Health Service, are presented in the accompanying table.

TABLE 1.—*Number of influenza cases reported in different geographic sections during recent weeks of the winter of 1930–31 and during the corresponding weeks of the winter of 1929–30*

Region	Week ended—									
	Dec. 6, 1930	Dec. 13, 1930	Dec. 20, 1930	Dec. 27, 1930	Jan. 3, 1931	Jan. 10, 1931	Jan. 17, 1931	Jan. 24, 1931	Jan. 31, 1931	Feb. 7, 1931
New England and Middle Atlantic:										
1930–31	27	40	51	62	102	540	1,390	2,156	2,153	1,205
1929–30	59	68	120	54	87	104	71	87	93	86
East North Central:										
1930–31	52	76	49	62	59	89	118	354	679	558
1929–30	60	91	78	104	90	163	190	151	111	91
West North Central:										
1930–31	8	9	13	9	31	27	24	122	119	101
1929–30	16	20	16	20	26	61	80	61	83	41
South Atlantic:										
1930–31	760	769	633	661	868	1,184	1,408	3,682	6,697	6,071
1929–30	1,127	1,144	786	1,093	1,466	1,366	1,239	1,269	1,232	1,466
East and West South Central:										
1930–31	214	239	322	180	365	626	679	831	1,087	1,184
1929–30	429	541	470	415	724	757	561	886	977	1,127
Mountain and Pacific:										
1930–31	111	86	121	106	85	157	129	173	261	294
1929–30	109	125	96	78	139	162	199	185	189	169
Total (all regions): [a]										
1930–31	1,172	1,219	1,189	1,080	1,520	2,623	3,748	7,318	10,996	9,413
1929–30	1,800	1,989	1,566	1,764	2,532	2,613	2,340	2,639	2,685	2,980

[a] 38 States and the District of Columbia included.

[1] From the Office of Statistical Investigations, U. S. Public Health Service. The numbers of States included for various diseases are as follows: Typhoid fever, 46; poliomyelitis, 47; meningococcus meningitis, 47; smallpox, 47; measles, 44; diphtheria, 46; scarlet fever, 46; influenza, 38.

[2] It should be recognized that these reports are incomplete and that the completeness of reporting varies greatly in the different regions.

The increase has clearly been sharpest in the North and South Atlantic sections, although there have been minor increases in the Great Lakes region also.

Some increase in mortality has taken place, but in general the cases seem to be of a very mild type.

Poliomyelitis.—The poliomyelitis incidence again declines, from 332 cases during the preceding 4-week period ended December 27 to 194 cases during the four weeks ended January 31. In October, 1929, the number of cases reported was more than four times as high as the number reported for the corresponding period of the preceding year. During the period ended December 27 this ratio stood at 2.9, and for the period ended January 31 it was 2.5.

The recent changes in the incidence of this disease have varied from section to section. The far west and the States west of the Great Lakes region have shown marked improvement, while in the remaining regions the ratio to last year has risen slightly since December.

Smallpox.—The number of reported cases of smallpox during the four weeks ended January 31 (4,276) was lower than for the corresponding period of last year (6,552) but higher than for 1929, when 2,960 cases were reported.

In some of the West North Central and South Central States, the recent incidence has risen somewhat more rapidly than the seasonal expectancy.

Scarlet fever.—The incidence of scarlet fever was somewhat higher than has been the experience of recent years. The number of cases reported during the 4-week period ended January 31 was 21,452, as compared with 19,030 last year and with 16,044 for the corresponding period of 1929. The incidence in relation to that of the same period of last year is higher especially in the following groups of States: New England (17 per cent), the Great Lakes (26 per cent), South Atlantic (20 per cent), and South Central (36 per cent). For the aggregated States the excess over last year is 13 per cent. In practically all these regions these excesses developed during the month of January.

Measles.—The number of cases of measles (29,666) reported during the 4-week period ended January 31 for the aggregated States is approximately one-third in excess of the cases reported in the corresponding period of each of the two preceding years. The excesses occur mainly in the South Atlantic, South Central, and West North Central regions.

Diphtheria.—For the States combined, diphtheria continues its gratifying low record. For the 4-week period ended January 31, 5,429 cases were reported, as against 6,706 last year—a decline of about 19 per cent. The decline obtained in all regions.

Meningococcus meningitis.—Improvement continues in meningococcus meningitis incidence. For the 4-week period ended January 31, 595 cases were reported, as compared with 942 last year—a decline of 37 per cent. The situation was slightly less favorable in the North Atlantic and South Central groups than in the remainder of the country, although in both areas the number of cases reported still fell below the number for last year.

Typhoid fever.—The incidence of typhoid fever dropped about 40 per cent during the month of January. The number of cases during the 4-week period ended January 31 (633) compared very favorably with the number reported for the same period in 1930. In both years, however, the disease was considerably more prevalent during the month than in January of 1929.

Mortality, all causes.—The mortality from all causes in a group of cities, as summarized in the Weekly Health Index of the Census Bureau, averaged 14.5 per thousand population, annual basis, as compared with 13.5 for the same period last year. In 1929, the rate for the corresponding period averaged 19.2, due to the influenza epidemic prevailing at that time.

STUDIES ON THE BIOCHEMISTRY OF SULPHUR

IX. THE ESTIMATION OF CYSTEINE IN THE PRESENCE OF GLUTATHIONE

By M. X. Sullivan, *Senior Biochemist*, and Walter C. Hess, *Assistant Chemist, National Institute of Health, United States Public Health Service*

Meldrum and Dixon, in their recent paper on "The properties of pure glutathione" (Biochemical Journal, 24, 472, 1930), found that the Sullivan (1926) reaction for cysteine was markedly inhibited by the presence of glutathione in the proportion of 9.0 mg. of glutathione to 1.0 mg. of cysteine. If Meldrum and Dixon's results can not be explained and set aright, the findings of these investigators would detract more or less from the quantitative and perhaps qualitative value of the Sullivan reaction for cysteine in extracts of tissue or in the evaluation of the purity of glutathione. The fact, however, is that, by slight modifications of the Sullivan reaction as originally published, cysteine can be estimated quantitatively in any proportion of glutathione, at least up to 100 glutathione to 1 of cysteine.

Indeed, if Meldrum and Dixon had followed the cysteine procedure detailed by Sullivan (1929) in the second paper of the series on "Studies in sulphur metabolism" they would have found that reduced glutathione in the proportion of 9.0 mg. to 1.0 mg. of cysteine has no inhibiting effect on the estimation of cysteine.

The proof of this statement is shown by the following experimental results recently obtained with a sample of glutathione prepared by Pirie's (1930) modification of the Hopkins' (1929) procedure and with a sample of cysteine hydrochloride made from cystine and freed from iron by Warburg's (1927) acetone treatment.

Tested by the Okuda (1925) iodine method with reduction by heating with zinc and hydrochloric acid (Okuda, 1929), both the glutathione and the cysteine hydrochloride were found to be at least 99 per cent in the reduced form.

EXPERIMENTAL

Glutathione and cysteine hydrochloride were dissolved separately in 0.1 N hydrochloric acid. Aliquots were then taken and mixtures made so that each 5 c. c. of the mixture contained 1.0 mg. of cysteine and glutathione in descending amounts 9.0, 8.0, 6.0, 4.0, 2.0, 1.0 mg., etc. The standard was 1.0 mg. of cysteine (1.3 mg. of cysteine hydrochloride) in 5 c. c.

The Sullivan reaction was then run on 5 c. c., in the manner that Meldrum and Dixon presumably ran it; that is, without the presence of cyanide. Thirty minutes were given to color development before adding the sodium hyposulphite ($Na_2S_2O_4$) and reading. The results given in Table 1 showed some inhibition of the cysteine reaction by glutathione.

TABLE 1.—*The estimation of cysteine in the presence of glutathione*

Glutathione-cysteine ratio	Per cent cysteine determined	Glutathione-cysteine ratio	Per cent cysteine determined
(A) Glutathione 9, cysteine 1	70	(F) Glutathione 1, cysteine 1	93
(B) Glutathione 8, cysteine 1	77	(G) Glutathione ½, cysteine 1	100
(C) Glutathione 6, cysteine 1	87	(H) Glutathione ¼, cysteine 1	100
(D) Glutathione 4, cysteine 1	91	(I) Glutathione ⅙, cysteine 1	100
(E) Glutathione 2, cysteine 1	93	Cysteine control 1.0 mg.	

For reasons that need not be detailed here, the inhibition shown in Table 1 suggested primary or secondary oxidation of cysteine, so the experiment was repeated in the presence of sodium cyanide to act as an antioxidant. Two series were run: (A) with 0.5 c. c. of 5 per cent aqueous sodium cyanide; (B) with 1 c. c. of 1 per cent sodium cyanide, before adding the naphthoquinone, etc. The procedure employed was as follows: To 5 c. c. of each solution and standard add the sodium cyanide, shake, and add 1 c. c. of a freshly prepared 0.5 per cent aqueous solution of 1.2 naphthoquinone-4-sodium sulphonate, shake (5 to 10 seconds), add 5 c. c. 10-20 per cent solution of anhydrous sodium sulphite in 0.5 N sodium hydroxide, mix, and wait

30 minutes at a temperature about 20° C. A reddish brown color appears. Then add 1 c. c. of a 2 per cent solution of sodium hyposulphite ($Na_2S_2O_4$) in 0.5 N sodium hydroxide. The brown red color in the presence of cysteine is converted to a purer red. The reaction is given by no other compound tested, not even by glutathione or cysteine amine. As shown by Sullivan and Hess (1930), even isocysteine is negative.

As shown in Table 2 no inhibition of the Sullivan cysteine reaction occurs when cyanide is present to prevent oxidation of the cysteine.

TABLE 2.—*The determination of cysteine in the presence of glutathione—in the presence of sodium cyanide*

Glutathione-cysteine ratio	Per cent cysteine determined	
	Series A	Series B
(1) Glutathione 9, cysteine 1	97	100
(2) Glutathione 8, cysteine 1	101	99
(3) Glutathione 6, cysteine 1	100	100
(4) Glutathione 4, cysteine 1	100	99.5
(5) Glutathione 2, cysteine 1	101	101
(6) Glutathione 1, cysteine 1	100	100

The experiment shows clearly that in the presence of cyanide (1 c. c. of a 1 per cent freshly prepared aqueous solution of sodium cyanide is satisfactory) glutathione has no inhibiting action on the Sullivan reaction at the ratio 9 glutathione to 1 cysteine employed by Meldrum and Dixon.

Even at the level, 18 mg. of glutathione to 1.0 mg. of cysteine, the colorimetric reading of the 1.0 mg. in the mixture was 19.8 when matched against 1.0 mg. of cysteine similarly treated and set at 20.

Higher proportions of glutathione to cysteine call for modification in the procedure. With modifications later detailed there is no inhibition of the cysteine reaction when the proportions are 36 to 1 or even 100 to 1.

The higher glutathione content calls for more naphthoquinone. When to the glutathione-cysteine mixture 36 mg. to 1 and to the standard cysteine solution 1.0 mg. in 5 c. c. 0.1 N hydrochloric acid there were added 1 c. c. of 1 per cent aqueous sodium cyanide and 1 c. c. of a 1 per cent solution of the naphthoquinone followed by the regular sodium sulphite in 0.5 N sodium hydroxide and then after 30 minutes color development by 1 c. c. of the $Na_2S_2O_4$ in 0.5 N sodium hydroxide, no inhibition occurred.

Under the same condition the mixture containing glutathione 100 mg., cysteine 1.0 mg., only 75 per cent of the cysteine was estimated. On increasing the naphthoquinone to 2 c. c. for the 100 to 1 mixture and for the standard, 89 per cent of the cysteine was estimated.

Since on theoretical grounds the apparent retardation of the Sullivan cysteine reaction in the 100 to 1 mixture seemed to be connected with the possible buffering action of the glutathione, the experiment with the glutathione-cysteine mixtures 100 to 1 was repeated with stronger alkali, as follows: To 5 c. c. of mixture and standard were added 1 c. c. of 1 per cent aqueous sodium cyanide, 2 c. c. of 1 per cent aqueous 1.2 naphthoquinone-4-sodium sulphonate, followed by 5 c. c. of 10 per cent sodium sulphite in N sodium hydroxide, and after 30 minutes standing by 1 c. c. of a 2 per cent solution of sodium hyposulphite in N sodium hydroxide. The average of four separate runs gave returns varying from 96.1 per cent to 100.8 per cent of the theoretical cysteine, with an average of 98.3 per cent.

Using the procedures detailed in this paper, cysteine can be estimated quantitatively by the Sullivan method in any proportion up to 100 glutathione to 1 cysteine.

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EXPERIMENTAL STUDIES OF NATURAL PURIFICATION IN POLLUTED WATERS

IV. THE INFLUENCE OF THE PLANKTON ON THE BIOCHEMICAL OXIDATION OF ORGANIC MATTER

By C. T. Butterfield, *Bacteriologist*, W. C. Purdy, *Plankton Expert*, and E. J. Theriault, *Chemist, United States Public Health Service*

The abstraction of dissolved oxygen from polluted water during the natural purification process is a well-known phenomenon. It is also well known that the amount of dissolved oxygen used up is definitely related to the amount of pollution present. While these facts in regard to the natural purification of polluted water are well established, the mechanism by which the oxidation is accomplished can only be surmised. For instance, if a portion of polluted water is examined, many bacteria and plankton are found. If all of these organisms are killed or removed from the water, oxidation ceases. The interreactions of these biological factors and the part that each plays in the process of natural purification constitute the subject of this study.

Extensive studies are described in the literature on the rate and extent of biochemical oxidation of polluted water. In general, these studies have been confined to a determination of the amounts of dissolved oxygen absorbed after various periods of incubation at different temperatures without reference to the biological factors concerned. Theriault (1927) presents a review of these studies. Among them, Dupré (1884) and Müller (1911) recognized that the oxidation phenomenon was dependent upon bacterial activity. Novy, Roehm, and Soule (1925), Novy and Soule (1925), and Soule (1925), studied the respiratory quotients (O_2 to CO_2 ratios) of certain bacteria and protozoa. Unfortunately for our purposes it was not necessary for these workers, in determining respiratory quotients, to obtain any information regarding the number of organisms at work or the amount of nutrient material consumed.

In his text "The Principles of Soil Microbiology," Waksman (1927, p. 339) discusses the interrelationships of protozoa and bacteria in the soil. "Decomposition of organic matter as well as other biological activities are resultants of the multiplication and growth of bacterial cells. By destroying the excess of bacteria, the protozoa may stimulate further bacterial development and, therefore, further biological transformations in the soil." A divergent view is held by Russell and Hutchinson, who attempt (Waksman, p. 755) "to correlate the destruction of protozoa following partial sterilization with the increase in the numbers of bacteria and their activities and subsequently soil fertility." Briefly stated, the opinion just quoted regards protozoa as probably inimical to soil fertility, whereas the opinion first quoted credits protozoa with probable usefulness to this same end.

Purdy and Butterfield (1918), in their study on the effect of plankton animals on bacterial death rates, showed quite clearly that certain of the protozoa are responsible for the destruction of large numbers of bacteria in the natural purification process. They also observed that when bacteria only were present, the bacteria soon reached a limiting number, which was maintained for several weeks, and that under such conditions, as judged by physical appearances, very little purification of the samples occurred. When plankton also were present, the limiting bacterial population was not maintained and the process of natural purification apparently proceeded to completion. Chemical examinations of the samples were not made.

PRELIMINARY EXPERIMENTS

At the start of the present study a number of preliminary experiments were made with samples containing such heterogeneous combinations of bacteria and plankton as are normally found in polluted river water. One of these experiments was performed on the Berkefeld filtrate of a raw sewage. One portion of this filtrate was inoculated with a heterogeneous mixture of bacteria, plankton-free, which had been isolated from the sewage. This portion, suitably diluted with plankton-free dilution water, was transferred to sterile dissolved oxygen bottles and incubated at 20° C. Daily determinations were made of the total bacterial count and of the dissolved oxygen content of the incubated samples, with occasional observations to verify the absence of plankton.

As a part of the same experiment, the remainder of the Berkefeld filtrate was inoculated with a small portion of raw sewage to restore the plankton as well as the bacteria which the unfiltered sewage originally contained. This second portion was then treated and examined as was the first portion, except that daily examinations for plankton were also made.

Whatever the expectancy may have been, it was found that oxidation was far more rapid in the samples which contained plankton than in those samples from which the plankton had been excluded, although the observed numbers of bacteria were greater in the absence of plankton. The more extensive oxidation observed in the plankton-bearing portion might be ascribed to the consumption of dissolved oxygen by the plankton. The greater variety of bacteria introduced with the sewage may also have been beneficial in promoting a more vigorous oxidation. Other factors are to be considered, including possible relationships between the bacteria and the plankton.

Because of the number of the variables involved these preliminary studies on samples of sewage containing heterogeneous inoculations, while instructive, did not offer any opportunity for determining the separate influence of the various biological factors concerned. Accordingly, it was decided to determine in a simple reproducible medium:

1. The oxidation, if any, which occurs in the absence of all living organisms.
2. The oxidation which takes place in the presence of pure or mixed cultures of bacteria in the absence of plankton.
3. The oxidation which is effected by pure cultures of plankton in the absence of bacteria.

4. The oxidation which occurs in the presence of both bacteria and plankton in pure and in mixed cultures.

Unless specific mention to the contrary is made, the medium selected for these experiments contained 0.005 gram each of dextrose and peptone per liter in phosphate—buffered solution. The growth characteristics of bacteria in this medium have already been described by one of us (Butterfield, 1929 *a*).

OXIDATION IN THE ABSENCE OF ALL LIVING ORGANISMS

Tests were made with the dilute dextrose-peptone solution to determine whether it would use up dissolved oxygen in the absence of living organisms. In making these tests the dilute medium, suitably sterilized, was thoroughly aerated and tested under various conditions. A second portion was inoculated with enough of a suspension of *Bact. aerogenes* to provide a count of 23,500 organisms per c. c. A third portion was inoculated with the same amount of the *Bact. aerogenes* suspension heated sufficiently to kill all living bacteria in it. For the tests the samples were transferred to sterile dissolved oxygen bottles, with precautions against the introduction of any contamination. All bottles were incubated at 20° C. At the start and at appropriate times thereafter two bottles from each series were removed from the incubator and examined to determine the bacterial content and the amount of dissolved oxygen left in solution. The bacteriological examinations were made by ordinary plating methods and also by direct microscopic count. The results obtained are presented in Table 1.

TABLE 1.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution when (1) no biological inoculation is added, (2) Bact. aerogenes are added, and (3) dead Bact. aerogenes are added*

Time, in days	(1) No biological inoculation added		(2) Bact. aerogenes added		(3) Dead Bact. aerogenes added	
	Bacteria per c. c.	Oxygen loss in p. p. m.	Bacteria per c. c. (living)	Oxygen loss in p. p. m.	Bacteria per c. c. (living)	Oxygen loss in p. p. m.
0	0	----------	23,500	----------	0	----------
	0	----------	23,500	----------	0	----------
1	0	−0.11	4,700,000	1.78	0	−0.02
	0	−.11	3,950,000	1.56	0	0.00
2	0	.19	4,500,000	2.55	0	.07
	0	.05	5,200,000	2.45	0	.08
3	----------	----------	4,550,000	2.85	0	.03
	----------	----------	4,500,000	2.77	0	.06
4	0	.18	4,950,000	2.75	0	.03
	0	.15	6,250,000	2.56	0	−.01
7	0	−.02	4,700,000	2.77	0	.08
	0	−.02	5,350,000	2.87	0	.04
10	(1)	----------	4,800,000	3.22	20	−.02
	----------	----------	4,700,000	2.81	3	−.09

[1] Bottles from this series were inoculated with bacteria at this time. These contaminated bottles produced results similar to those observed when living bacteria were added at the start.

It is noted that in the absence of bacteria no appreciable oxygen loss was observed in this medium during 10 days of storage at 20° C. Similarly, deoxygenation did not occur when dead cells of *Bact. aerogenes* were present. When the medium was inoculated with living cells of *Bact. aerogenes* at the start, they multiplied rapidly, and a corresponding loss in the dissolved oxygen content of the medium was observed. As a counter control some bottles of the sterile medium were removed from the incubator on the tenth day and inoculated with bacteria. The subsequent history of these bottles was the same as that of the bottles which received living bacteria at the start.

OXIDATION IN THE PRESENCE OF PURE CULTURES OF BACTERIA

The major portion of the work with pure cultures of bacteria was done with *Bact. aerogenes*. In these experiments an attempt was made to establish definite limits for the oxygen requirements of this organism under standard conditions in order that when grown in combination with plankton the symbiotic effect and the oxygen requirements of the plankton as such might more definitely be estimated. A few tests were made with pure and with mixed cultures of other bacteria, *proteus*, *coli*, and a small sewage coccus, to determine the extent to which the findings with *Bact. aerogenes* were representative of bacterial oxidation.

In the following tests to determine the oxygen requirements of *Bact. aerogenes* growing under standard conditions the dilute dextrose-peptone solution was prepared and sterilized, usually in 10-liter quantities. The inoculation with *Bact. aerogenes* was accomplished by taking the growth from a 24-hour 37° C. agar slant and suspending it in 100 c. c. of sterile water. Varying amounts of this suspension were added to the sterile medium, depending on the initial concentration of bacterial cells desired. One c. c. of this suspension per liter of medium yielded an initial bacterial content of approximately 60,000 per c. c. (A 24-hour, 37° C. agar slant of *Bact. aerogenes* with an inoculated surface ½ by 2½ inches in area usually contains 5 to 7 billion viable cells.) The temperature of the inoculated medium was then brought to 20° C., and it was vigorously agitated to insure thorough mixing and a proper dissolved oxygen content. The medium was then allowed to stand for a few minutes to permit the escape of any entrained air and was then siphoned to sterile dissolved-oxygen bottles, suitable precautions being taken to prevent the entrance of any contamination.

At the start of a test, determinations were made of the bacterial count and dissolved oxygen content of some of the first and of the last bottles filled. No appreciable differences were observed at any time between the first and the last portions withdrawn. All bottles were stored in an incubator, held at a constant temperature of 20° C. Examinations were made at appropriate time intervals thereafter to determine the number of *Bact. aerogenes* per c. c. and the residual dissolved oxygen content. Tests were also made to determine whether any extraneous bacteria or plankton had gained entrance to the bottles. As a rule, two bottles were analyzed at each period, and the results secured from these duplicates were generally in good agreement. The results obtained from nine such experiments are presented in Table 2. The A and B sections of the table contain the bacteriological and chemical results, respectively.

TABLE 2.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution, incubated at 20° C., when inoculated with a pure culture of bacteria*

Time, in days	Experiment No.									Average
	4	5	6	7	8	14	15	16	17	
A. BACT. AEROGENES PER C. C.										
0	48,000	4,250,000	88,000	239,000	1,000,000	37,700	640,000	370,000 417,000	85,000 84,000	753,000
1	2,700,000	11,400,000	5,000,000	6,650,000	6,700,000	5,400,000 5,600,000	5,200,000 6,800,000	6,700,000 7,200,000	4,100,000 4,500,000	6,130,000
2	6,200,000	12,300,000	7,800,000	6,350,000	7,500,000	[1] 5,900,000	6,800,000 6,550,000	8,250,000 9,050,000	7,400,000 7,200,000	7,630,000
3	6,800,000	13,400,000	6,200,000	7,000,000	6,900,000	6,400,000 6,200,000	[1] 6,290,000	8,800,000 6,700,000	7,800,000 7,700,000	7,600,000
4	5,500,000	[1] 12,900,000	7,000,000	6,100,000	6,750,000	6,300,000	5,800,000 6,000,000	9,100,000	[1] 7,160,000	7,410,000
5	6,100,000	12,400,000	5,600,000	5,800,000	6,700,000	4,750,000	7,050,000 6,600,000	9,600,000	6,450,000 6,700,000	7,150,000
6	6,250,000	12,700,000	6,650,000	6,300,000	6,050,000	[1] 4,480,000	6,500,000 5,900,000	[1] 9,300,000	8,900,000	7,430,000
7	7,800,000	10,800,000	5,800,000	5,550,000	7,300,000	4,200,000	6,500,000	9,000,000	6,600,000	7,060,000
8	5,450,000	11,200,000	5,700,000	6,900,000	6,550,000	6,300,000	6,300,000	7,900,000	8,150,000	7,160,000
10	5,800,000	10,800,000	5,800,000	6,900,000	6,800,000	4,900,000	6,170,000	7,500,000	7,000,000	6,850,000
15 [2]	----------	7,650,000	4,200,000	4,150,000	4,350,000	4,100,000	6,200,000	6,100,000	----------	[2] 5,250,000
B. OXYGEN LOSS IN P. P. M.										
1	1.96	----------	2.33	2.57	2.49	2.06 1.92	2.05 1.88	2.83 2.06	2.23 2.09	2.24
2	3.07	2.83	2.50	2.75	2.44	[1] 2.48	3.12 2.28	3.17 2.63	3.30 3.30	2.77
3	2.63	2.94	2.53	2.61	2.54	3.01 2.94	[1] 2.56	2.69 2.47	3.35 3.36	2.75
4	2.76	[1] 3.03	2.50	2.91	2.74	2.95	2.44 2.37	2.64	[1] 3.45	2.83
5	2.79	3.23	2.56	3.13	3.69	3.13	2.45 2.30	3.01	3.58 3.50	3.05
6	2.81	3.64	2.89	3.20	2.53	[1] 3.17	2.47 2.37	[1] 2.90	3.63	3.02
7	2.80	3.21	2.55	2.86	3.17	3.21	2.30	2.79	3.69	2.95
8	2.60	2.80	2.56	2.89	3.03	3.23	2.94	3.04	3.67	2.97
10	3.07	2.89	2.66	3.64	3.41	3.08	3.02	3.00	3.70	3.16
15 [2]	----------	3.01	3.32	3.48	2.32	3.37	2.86	4.00	----------	[2] 3.19

[1] Calculated figure; mean of preceding and following results.
[2] Includes results obtained at 13 to 16 days.

The results obtained in this series of experiments indicate that within 48 hours after inoculation into a sterile dextrose-peptone medium the total count of *Bact. aerogenes* increases to a limiting figure which is fairly uniform in the different experiments. Growth of bacteria then appears to cease, but the maximum count is sustained for several days.

It is noteworthy that oxygen is absorbed at a rapid rate only while the bacteria are in a state of active multiplication. This absorption of oxygen practically ceases after the limiting number of bacteria has been reached, even though the viable bacterial population remains quite high, (10,000,000 cells per c. c. in some experiments). This observation has been supported in experiments where the examinations have been continued for 30 or 40 days. The indications are that under the given conditions, the oxygen requirement of resting bacterial cells is negligibly small (less than 0.01 part per million of oxygen daily per million bacteria). It also seems fair to conclude that biochemical oxidation is effected only by growing cells.

Using the same technique as in the experiments with *Bact. aerogenes*, tests were also made with *Bact. proteus*, *Bact. coli*, and a small coccus isolated from sewage. The first strain of *Bact. coli* tried failed to grow in the dilute medium at 20° C., though it grew well at 30° and 37° C. Another strain of *Bact. coli* was used which did grow well in the dilute medium at 20° C. This strain had the cultural characteristics of the so-called fecal type. The bacteriological and the oxygen results obtained in these experiments with cultures other than of *Bact. aerogenes* are presented in Table 3, sections A and B, respectively. The average results previously obtained with *Bact. aerogenes* in the same medium are also included for comparative purposes.

TABLE 3.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution incubated at 20° C., when inoculated with bacteria in pure culture*

Time, in days	Bact. aerogenes average 9 experiments	Bact. coli		Bact. proteus		Small sewage coccus, experiment No. 34
		Experiment No. 37	Experiment No. 41	Experiment No. 31	Experiment No. 32	
A. BACTERIA PER C. C.						
0	753,000	61,900	31,000	7,900	200	1,190
1	6,130,000	2,960,000	6,400,000	3,460,000	42,000	70,500
2	7,630,000	5,380,000	9,700,000	5,280,000	5,650,000	16,400,000
3	7,600,000	5,020,000	8,800,000	6,220,000	6,100,000	18,200,000
4	7,410,000			5,100,000	5,500,000	
5	7,150,000		10,200,000	4,900,000	5,700,000	19,300,000
6	7,430,000	5,550,000	9,980,000			
7	7,060,000			4,320,000	5,900,000	18,800,000
10	6,850,000	4,300,000	10,100,000	3,220,000	4,680,000	18,000,000
15	5,250,000	5,080,000	8,920,000	3,290,000	3,850,000	20,200,000
B. OXYGEN LOSS IN P. P. M.						
1	2.24	1.52	2.42	1.34	0.02	0.23
2	2.77	2.04	3.06	3.67	2.46	2.43
3	2.75	2.29	3.40	4.10	3.94	3.17
4	2.83			4.26	4.22	
5	3.05		3.66	4.59	4.64	2.96
6	3.02	2.66	3.88			
7	2.95			4.72	4.75	3.18
10	3.16	2.78	4.47	4.56	4.67	3.68
15	3.19	2.90	3.95	4.02	4.79	3.98

As already noted in experiments with *Bact. aerogenes*, each pure culture increased rapidly until a limiting number was reached, and thereafter no marked change in the count was observed for several days. As before, active deoxygenation took place only during the growth period, and it practically ceased after the maximum count was reached. It is to be noted that the limiting number of bacteria developing is somewhat different for each species and that the extent of the oxygen loss also varies slightly with different bacteria. In fact, these differences are explainable on the basis of known relationships between the limiting number of bacteria, the size of the individual organisms, and the concentration of the food, as already discussed in an earlier paper (Butterfield, 1929 *b*). Variations in the extent of oxygen absorption are also to be expected as a result of differences in the availability of the food material to the various species of bacteria. Greater significance attaches to the observation that in all experiments bacterial multiplication ceased after a few days' incubation and that this cessation of activity was reflected in the oxygen results.

OXIDATION IN MIXED CULTURES OF BACTERIA WHEN PLANKTON ARE ABSENT

On the basis of preliminary work with sewage organisms it appeared desirable to use inoculations of graded complexity when work was undertaken with mixed cultures. In the first experiment only two species of bacteria were used, namely, *Bact. aerogenes* and an unidentified organism which produced a yellow pigment. This latter bacterium had been frequently found associated with the protozoon *Colpidium*. In the next experiment a mixture consisting of four stock cultures—*Bact. aerogenes*, *Bact. proteus*, *Bact. coli*, and *Bact. subtilis*—was used. In two other experiments the above stock cultures were used together with a number of unidentified cultures picked at random from plates made from river water and sewage. These mixtures contained, respectively, 15 and 18 different strains of bacteria. An attempt to obtain a more complex mixture by washing the growths from plates made from river water and sewage was unsuccessful, as several varieties of plankton, which had multiplied or perhaps only survived on the plates, were found in the inoculation. The results obtained in these experiments with mixed cultures of bacteria are given in Table 4, section A containing the bacteriological and section B the oxygen results.

Table 4.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution incubated at 20° C., when inoculated with bacteria in mixed culture, but free from plankton*

Time, in days	2 bacterial species	4 bacterial species		15 bacterial species		18 bacterial species	
	Experiment No.						
	24	31	32	62	63	60	61
A. BACTERIA PER C. C.							
0	470,000	6,250	141	4,820	5,090	6,550	9,650
1	4,900,000	2,360,000	27,500	7,920,000	8,080,000	5,050,000	5,400,000
2	5,600,000	6,220,000	6,520,000	7,480,000	9,880,000	7,020,000	6,420,000
3	15,100,000	7,120,000	6,680,000	9,420,000	10,500,000	6,100,000	5,200,000
4	13,500,000	5,050,000	7,180,000			6,220,000	8,120,000
5	15,200,000	7,750,000	5,050,000	6,120,000	8,920,000	6,500,000	7,380,000
7	5,600,000	4,450,000	5,480,000	7,580,000	10,000,000	5,550,000	5,680,000
9	12,200,000			4,780,000	8,900,000	5,000,000	6,100,000
10	13,000,000	4,250,000	5,380,000	6,950,000	8,000,000	2,300,000	1,880,000
15	7,800,000	4,350,000	4,680,000	5,500,000	7,500,000	2,280,000	3,810,000
B. OXYGEN LOSS IN P. P. M.							
1	2.02	0.96	−0.05	3.46	3.40	1.84	3.24
2	2.60	3.16	2.28	3.77	3.86	2.95	4.00
3	3.72	3.86	3.82	3.85	3.99	4.36	4.35
4	4.46	4.08	4.05	4.09	4.06	2.92	4.52
5	5.21	4.10	4.30	4.33	4.14	2.99	4.72
7	4.76	4.50	4.71	4.43	4.49	3.36	4.74
9	5.07	4.46	4.68	4.50	4.40	3.28	5.00
10	5.30	4.42	4.64	4.80	4.34	3.82	5.20
15	5.15	4.41	5.00	4.65	4.49	4.52	5.15

The data presented in Table 4 are in good general agreement with the results obtained with pure cultures. As before, (1) the bacteria increased in numbers until a limiting population was reached, which (2) was sustained for several days. (3) Oxygen was used up at a rapid rate, but (4) only while the bacteria were in a state of active multiplication. The circumstance that the total oxygen demand is somewhat greater with mixed than with pure cultures accords satisfactorily with our knowledge of the food idiosyncrasies of bacteria. With increasing complexity of inoculation it is to be expected that the proportion of unutilized food would diminish.

Thus these four significant facts regarding bacterial growth and oxygen depletion, in the absence of plankton, have been established for certain bacteria growing in pure culture and also in fairly heterogeneous mixtures. In this connection it should be noted that in a few experiments the bacterial counts and oxygen depletions have been followed for 30 to 40 days without observing any marked change.

It is to be noted that the experiments already presented were all conducted in a buffered medium containing 0.005 gram (5 mg.) each of dextrose and peptone per liter. While the results at this food concentration are reasonably consistent, it appeared desirable to repeat some of these experiments in media of different concentration. In the experiments presented in Table 5 the food concentration in terms of dextrose and peptone was accordingly varied from 1 to 12 mg. per liter. *Bact. aerogenes* was used for the inoculation, and the technique followed was the same as in previous experiments. The results for the first four days are the average values obtained from duplicate samples at each concentration. The figures for the fifth day are the average values obtained from four closely agreeing observations. In all cases the observed depletion of oxygen has been referred to the amount used up with 5 mg. each of dextrose and peptone per liter, that is, the observed loss with 1 mg. per liter was multiplied by five, etc. The bacterial figures, however, are unchanged.

TABLE 5.—*Bacterial counts and oxygen depletions observed in dilute media containing various amounts of dextrose and peptone, when inoculated with Bact. aerogenes in pure culture and incubated at 20° C.*

Time, in days	Milligrams each of dextrose and peptone per liter				
	1.0	2.5	5.0	8.0	12.0
A. BACT. AEROGENES PER C. C.					
0	7,600	20,300	34,100	47,000	111,000
5/24	7,900	26,600	58,800	102,000	232,000
1	41,500	702,000	6,050,000	10,400,000	16,100,000
2	52,500	1,280,000	6,780,000	11,700,000	16,700,000
3	59,200	1,160,000	5,950,000	10,700,000	19,600,000
4	45,500	1,060,000	7,350,000	11,000,000	20,200,000
5	44,000	1,030,000	7,320,000	12,400,000	18,800,000
B. OXYGEN LOSS [1] IN P. P. M.					
5/24	0.02	−0.02	0.04	0.02	0.04
1	0.15	1.55	2.10	2.06	2.14
2	2.85	2.57	2.66	2.49	2.58
3	2.92	2.75	2.68	2.54	2.68
4	2.55	2.72	2.70	2.62	2.64
5	2.98	2.94	2.80	2.69	2.62

[1] Results obtained by multiplying the observed depletion by the factor required to express each in terms of the 5.0 mg. per liter concentration.

Bacterial growth with 1 and 2 mg. each of dextrose and peptone per liter was slower and less regular than in media containing larger amounts of food. The oxygen demand results show a slight but systematic tendency to increase with decreasing concentrations. In part this trend is due to the omission of any correction for the oxygen demand of the dilution water. Irrespective of concentration, the absorption of dissolved oxygen practically ceased after a few days.

The conclusion drawn from these and similar experiments is that growth of bacteria, either in pure or in mixed culture, presents certain definite and readily reproducible characteristics which are not greatly altered by variations in food concentration within the usual pollutional loading of streams.

OXIDATION BY PURE CULTURES OF PLANKTON IN THE ABSENCE OF BACTERIA

The isolation of certain kinds of plankton in pure culture but not free from bacteria presents but few difficulties greater than those which are encountered in the similar isolation of bacteria. But the freeing of individual organisms of such a plankton culture from bacteria is a tedious and time-consuming operation. Even this, however, can be accomplished with patience and careful technique, but it is only a small part of the problem of maintaining plankton in pure, bacteria-free culture. A medium must be available in which the bacteria-free organism will multiply. Of necessity this medium must be selected by the trial and error method. The desired organism, freed from bacteria, is placed in the sterile medium under trial. If growth occurs and the medium remains bacteria-free, success is attained.

At the start of these investigations it was planned to study the activities of at least three plankton organisms in bacteria-free culture. With this in view, attempts were made to isolate (1) a very small plankton, (2) a plankton of medium proportions, such as *Colpidium*, and (3) one of the larger organisms, such as *Paramecium* or *Oxytricha*. Attempts to secure the small plankton in bacteria-free culture failed, although it was successfully grown in media containing a very limited number of bacteria species. *Colpidium* [1] was obtained and successfully perpetuated in bacteria-free culture. Thus far all efforts [2] to obtain either *Paramecium* or *Oxytricha* in bacteria-free culture have failed, although much time has been spent on *Paramecium*, a large number having been washed free from bacteria and inoculated into a variety of media.

Consideration is now given to the results obtained with *Colpidium*. In the experiments with bacteria only, described above, a synthetic medium, containing 5 mg. each of dextrose and peptone per liter of phosphate-buffered dilution water, was employed. *Colpidium* in a bacteria-free state has invariably failed to grow in this medium, although this ciliate grows luxuriantly in this same medium when a slight initial inoculation of living bacteria is added.

By increasing the concentrations of dextrose and peptone in this medium it was found that when 500 or more mg. of each were present per liter, *Colpidium* would multiply and reach very high numbers even in the absence of all bacterial life.

Preliminary experiments were made to determine the amount of dissolved oxygen consumed by *Colpidium* growth in this more concen-

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[1] Isolated by Dr. M. A. Barber, U. S. Public Health Service.

[2] Recent work not within the scope of this paper seems to have been successful with *Paramecium*.

trated medium. The tests were made by the standard dissolved oxygen analytical procedures before the experimental difficulties with these procedures in the presence of such large amounts of organic materials were definitely known. These experiments are nevertheless of value, for the results obtained serve to fix roughly the upper limits of oxygen consumption, inasmuch as the experimental errors involved invariably tended apparently to increase the loss in dissolved oxygen in the medium. Four such preliminary experiments were made. The procedure given for the cultures of bacteria only was followed, with the exceptions that the concentrations of dextrose and peptone in the medium were much greater and that bacteria-free *Colpidium* was the only inoculation added. In every case the incubated sample in which the residual dissolved oxygen was determined was also examined to ascertain the number of *Colpidium* per c. c. and to establish the absence or presence of bacterial contamination. Occasional bottles were found on the fifth day of storage and thereafter which had become contaminated with bacteria. The results obtained from such bottles were of course eliminated from consideration.

Owing to the inherent, slower rate of multiplication of such plankton organisms as *Colpidium*, as compared with the rate of division of bacterial cells, observations made at shorter intervals of time than five days are not instructive. The results obtained in these preliminary experiments are presented in Table 6.

TABLE 6.—*Colpidium counts and oxygen depletions observed in dextrose-peptone solutions inoculated with Colpidium in pure, bacteria-free culture and incubated at 20° C.*

Time of incubation, in days	Concentration of dextrose and of peptone in mg. per liter	Colpidium per c. c. in cubic standard units	Oxygen depletion in p. p. m.
5	5,000	10,350	3.17
5	500	906	1.01
15	500	1,780	2.23
20	500	4,830	5.68

Repetitions of these experiments, using the improved technique and apparatus described by Theriault and Butterfield (1929) for the determination of oxygen demand in the presence of unusual amounts of organic material, provided data of greater quantitative significance. For these tests the concentration of dextrose and of peptone was increased to 5,000 mg. per liter. No difficulty was experienced in obtaining accurate oxygen demand results with this apparatus and procedure. Examinations were made at frequent intervals for 27 days to determine (1) the *Colpidium* content, (2) the oxygen depletion, and (3) the absence of any bacterial contamination. The results obtained from one such test with a pure, bacteria-free culture of *Colpidium* are presented in Table 7.

TABLE 7.—*Colpidium counts and oxygen depletions observed in a solution containing 5,000 mg. each of dextrose and of peptone per liter when inoculated with a pure culture of Colpidium and incubated at 20° C.*

Time, in days	Oxygen depletion in p. p. m.	Colpidium per c. c.		Bacteria per c. c.
		Individuals	Cubic standard units	
0		3	6	None.
1	7.0	4	9	Do.
2	9.5	13	26	Do.
4	9.0	83	224	Do.
5	9.2	190	570	Do.
7	11.8	755	2,643	Do.
8	11.5	1,410	5,076	Do.
9	13.5	2,730	12,285	Do.
11	34.0	6,230	23,674	Do.
12	57.0	8,300	29,880	Do.
13	78.7	10,280	39,064	Do.
14	95.4	12,260	47,814	Do.
15	130.5	14,000	67,200	Do.
16	148.3	15,000	72,000	Do.
18	175.7	12,700	50,800	Do.
19	190.9	13,650	54,600	Do.
21	226.4	14,150	62,260	Do.
23	244.8	15,600	67,080	Do.
25	265.4	14,200	55,380	Do.
27	297.5	13,750	59,125	Do.

In this experiment the *Colpidium* increased in numbers until a maximum was reached on about the sixteenth day. The oxygen depletion of 148.3 parts per million observed on the sixteenth day slowly increased to 297.5 parts per million on the twenty-seventh day, although there was no further increase of the *Colpidium*.

When inoculated with *Bact. aerogenes* in pure culture, the 5-day oxygen demand of this medium, containing 5,000 mg. each of dextrose and peptone per liter, is about 3,000 parts per million. To obtain additional information in regard to the oxygen demand of this medium a portion of the medium in which the *Colpidium* had been growing for 27 days was removed and inoculated with the heterogeneous flora and fauna found in polluted river water. An additional oxygen depletion of 6,880 parts per million after 5 days and 8,350 parts per million after 10 days was observed. At the time the above portion of the medium was removed to determine its residual oxygen demand in the presence of a combination of bacteria and plankton, the remaining *Colpidium*-only portion in the container was treated with sufficient acid to kill the *Colpidium*. No further loss of oyxgen was observed in this portion.

In the light of these observations it seems logical to conclude that the oxygen depletions produced by the growth of *Colpidium*, in the absence of bacteria, are only a small portion of that observed in the presence of bacteria or of combinations of bacteria and plankton.

OXIDATION BY PURE CULTURES OF BACTERIA AND OF PLANKTON GROWING TOGETHER

In this part of the study with plankton and bacteria growing together, each in pure culture, the greater portion of the work has been done with the combination of *Bact. aerogenes* and *Colpidium*, inasmuch as the oxygen depletions produced by each of these organisms, when growing individually in pure culture, have been rather definitely established. These tests were made with the same dilute dextrose-peptone solution and with exactly the same technique as that employed in the studies reported above. In almost every instance the pure culture bacteria experiments and the bacteria and plankton combination experiments were run in parallel. Two exactly duplicate portions of the dilute medium were prepared and each was inoculated with the same amount of bacterial suspension. One of these portions was also seeded with a definite amount of an active *Colpidium* culture. Usually a similar amount of the *Colpidium* culture was killed by heat and added to the portion containing bacteria in pure culture in order that there might be no question as to the exact duplication of the oxidizable material present in the two series. Thereafter each of the two portions was thoroughly mixed and distributed to sterile dissolved oxygen bottles for subsequent study.

In these tests with *Bact. aerogenes* and *Colpidium* growing together, examinations were made, usually in duplicate, at regular intervals, to determine (1) the number of *Bact. aerogenes* per c. c., (2) the number of cubic standard units of *Colpidium* per c. c., (3) the extent of oxygen depletion, and (4) whether any organisms other than *Bact. aerogenes* or *Colpidium* had gained entrance to the bottles. In a few instances bottles were found, after the fifth day of storage, which contained extraneous organisms. The results obtained from such bottles were excluded.

Ten such experiments with *Bact. aerogenes* and *Colpidium* have been completed. The results obtained in each experiment, together with the average of the 10, are presented in Table 8. The A, B, and C sections contain, respectively, the bacteriological, the plankton, and the oxygen data.

TABLE 8.—*Bacteria and Colpidium counts and oxygen depletions observed in dilute dextrose-peptone solutions incubated at 20° C., when inoculated with Bact. aerogenes and Colpidium, each in pure culture*

Time, in days	Experiment No.										Average
	5	6	7	8	15	16	17	23A	23B	23C	
A. BACT. AEROGENES PER C. C.											
0	4,300,000	92,000	240,000	1,030,000	622,000	422,000	90,000	350,000	350,000	350,000	781,000
						359,000	75,000				
1	15,000,000	4,900,000	6,800,000	6,100,000	6,700,000	7,750,000	4,250,000	6,800,000	6,400,000	5,100,000	6,940,000
	9,650,000	6,200,000	6,400,000	7,000,000	6,900,000	8,800,000	5,700,000	6,100,000	6,900,000	5,300,000	
2	1,080,000	6,250,000	6,150,000	4,500,000	4,800,000	9,200,000	6,600,000	6,500,000	5,900,000	6,200,000	6,050,000
	2,080,000	6,700,000	7,350,000	3,760,000	6,900,000	10,100,000	6,900,000	7,400,000	6,800,000	5,900,000	
3	650,000	5,900,000	5,700,000	270,000	[1] 5,850,000	8,700,000	10,700,000	670,000	4,200,000	4,650,000	4,522,000
	350,000	5,700,000	4,800,000	220,000		9,200,000	8,300,000	520,000	2,500,000	5,700,000	
4	[1] 565,000	5,400,000	4,500,000	365,000	6,200,000	5,700,000	[1] 5,120,000	190,000	260,000	6,500,000	3,170,000
		3,750,000	3,280,000	354,000	5,500,000			130,000	90,000	4,100,000	
5	570,000	730,000	590,000	340,000	3,520,000	5,700,000	890,000	[1] 132,000	[1] 160,000	[1] 2,880,000	1,640,000
	690,000	2,450,000	700,000	315,000	3,640,000		585,000				
6	845,000	780,000	1,210,000	500,000	870,000	[1] 5,000,000	1,280,000	159,000	176,000	480,000	1,060,000
	805,000	370,000	1,140,000	350,000	420,000			48,000	115,000	420,000	
					660,000						
7	480,000	380,000	1,380,000	194,000	560,000	4,300,000	760,000	238,000	149,000	690,000	873,000
	219,000	415,000	795,000	266,000	720,000			238,000	247,000	390,000	
8	635,000	475,000	485,000	175,000	980,000	3,600,000	680,000	47,000	129,000	530,000	793,000
	570,000	660,000	865,000	210,000				39,000	41,000	470,000	
10 [2]	450,000	810,000	930,000	331,000	700,000	2,770,000	520,000	218,000	340,000	339,000	[2] 705,000
		510,000	490,000	347,000							
15 [3]	366,000	372,000	476,000	237,000	805,000	2,100,000		63,500	158,000	330,000	[3] 545,000

[1] Calculated figure mean of preceding and following results.
[2] Includes results of ninth to eleventh days.
[3] Includes results of thirteenth to sixteenth days.

TABLE 8.—*Bacteria and Colpidium counts and oxygen depletions observed in dilute dextrose-peptone solutions incubated at 20° C., when inoculated with Bact. aerogenes and Colpidium, each in pure culture*—Continued

Time, in days	Experiment No.										Average
	5	6	7	8	15	16	17	23A	23B	23C	
B. COLPIDIUM PER C. C. IN CUBIC STANDARD UNITS											
0	7.0	10	10.0	10	40	6	5	0.5	1	2	9.2
1	71.0	6	4.0	14		0	0	7	7	1	12.4
						0	0	4	12	0	
2	443.0	9	22.3	423	8	8	24	36	30	68	108.7
						8	16	33	104	48	
3	804.0	48	156.0	720	[1] 78	158	220	3,367	320	320	511.8
						65	380	1,116	472	204	
4	[1] 404.0	93	456.0	102	164	360	[1] 700	1,120	1,410	660	538.2
		438	440.0	72	144			830	1,485	420	
5	3.0	459	456.0	92	304	685	960	[1] 817	[1] 944	[1] 560	535.0
		414	552.0	51	152		1,242				
6	7.5	240	512.0	498	290	[1] 461	384	762	382	614	358.8
		56	288.0	9	214			556	500	548	
7	48.0	12	176.0	344	10	237	56	66	176	424	149.6
		6	204.0	8	8			268	216	392	
8	37.0	15	12.0	64	[1] 8	248	108	102	24	98	83.0
		22	20.0	54				294	50	124	
10 [2]	19.0	6	12.0	6	5	191	0	27	30	26	[3] 33.1
		27	12.0	4							
16 [2]	74.0	19	51.0	6	1	85		15	4	15	[3] 30.0

C. OXYGEN LOSS IN P. P. M.

1		2.37	2.64	2.32		2.80	2.77	2.24	2.19	2.27	2.42
					2.40	2.53	2.79	2.21	2.27	2.08	
2	3.95	2.82	2.60	2.67		3.78	4.22	2.40	2.68	3.67	3.15
					2.89	3.64	4.33	2.40	2.67	3.27	
3	4.32	2.69	2.63	3.40	[1] 2.84	3.89	5.11	4.14	3.78	4.31	3.76
						3.79	5.64	4.11	4.20	4.47	
4	[1] 4.48	3.13	2.88	3.35		4.29	[1] 6.54	5.54	5.11	4.83	4.33
		3.17	2.83	3.54	2.78			5.46	5.48	5.12	
5	4.65	4.99	3.27	3.48		4.77	7.64	[1] 5.89	[1] 5.78	[1] 5.56	4.85
		3.21	3.53	3.66	3.10		7.79				
6	4.47	3.54	3.30	5.51		[1] 5.34	7.69	6.29	6.09	5.85	5.24
		4.50	4.93	3.82	3.40			6.27	6.44	6.44	
					3.51						
7	4.52	3.38	3.16	5.32	3.50	5.90	8.48	6.50	6.63	6.41	5.38
		3.38	3.69	3.59				7.05	6.84	6.82	
8	5.05	3.43	4.05	4.99	3.76	6.24	8.39	7.57	6.61	6.81	5.74
		5.04	3.78	5.21				6.90	6.84	6.63	
10 [2]	4.58	3.19	3.54	3.62	3.56	6.91	8.40	6.98	7.32	7.44	[3] 5.50
		3.90		3.69							
15 [3]	5.02	3.89	3.75	5.08	3.88	7.47	8.52	7.25	6.93	7.14	[3] 5.89

[1] Calculated figure mean of preceding and following results.
[2] Includes results of ninth to eleventh days.
[3] Includes results of thirteenth to sixteenth days.

The results obtained with *Bact. aerogenes* and *Colpidium* growing together in the test medium appear to warrant the following deductions:

(1) The bacteria increased very rapidly in numbers to a limiting figure of about seven millions per c. c. during the first 24 hours.

(2) The *Colpidium* increased slowly, requiring three to six days to reach their limiting number. (The incidence of the *Colpidium* growth was apparently favorably influenced by increases in the initial bacterial density.)

(3) Coincident with or immediately following the increase of the *Colpidium*, the observed bacterial count began to decrease. By the time the *Colpidium* had reached its limiting number, the bacteria had been reduced about one-half, and thereafter both the bacteria and the *Colpidium* decreased.

(4) The absorption of oxygen proceeded at a rapid rate while the bacteria were in an observed state of active increase.

(5) In the experiments with bacteria and plankton growing together the absorption of oxygen continued not only after the limiting number of bacteria had been reached but also after the limiting volume of *Colpidium* was observed. This was not the case in the pure culture experiments with bacteria alone. Here the absorption of oxygen practically ceased when the limiting number of bacteria was reached.

These deductions and comments may be understood better by referring to Figures 1 and 2, which portray graphically the average results presented in Tables 2 and 8. Figure 1 presents the biological results and Figure 2 the corresponding oxygen depletions.

If biochemical oxidation be effected only by growing cells, then it is necessary to conclude that actual multiplication of the bacteria occurred continuously in these experiments, although the observed number of bacteria present was for the greater part of the time continuously decreasing.

It has been shown that in a more concentrated medium the *Colpidium* is able to take on sufficient food to stimulate growth in the absence of bacteria, and this organism is not able to do this in the dilute medium. Since *Colpidium* did grow well in the dilute medium in the presence of bacteria and a marked decrease in bacterial numbers was observed, it seems reasonable to conclude that the bacteria, by absorbing the food and thus concentrating it in their own bodies, became a sufficient food in themselves to stimulate the growth of *Colpidium*. Thus the bacteria may be said to be "concentrators" or "condensers" of the dilute food material.

It may be assumed, under the conditions of these tests, that *Colpidium* was responsible for the marked decrease in bacterial numbers. This assumption is supported by the earlier studies of Purdy and Butterfield (loc. cit.). With the bacterial population reduced below its limiting number by the inroads of the plankton, the bacteria would be stimulated to maintain continuous growth.

On the basis of these considerations the function of the plankton in the biochemical oxidation process is to maintain the bacterial population below its limiting number. As a result, compensatory bacterial multiplication is stimulated and a continuation of the oxi-

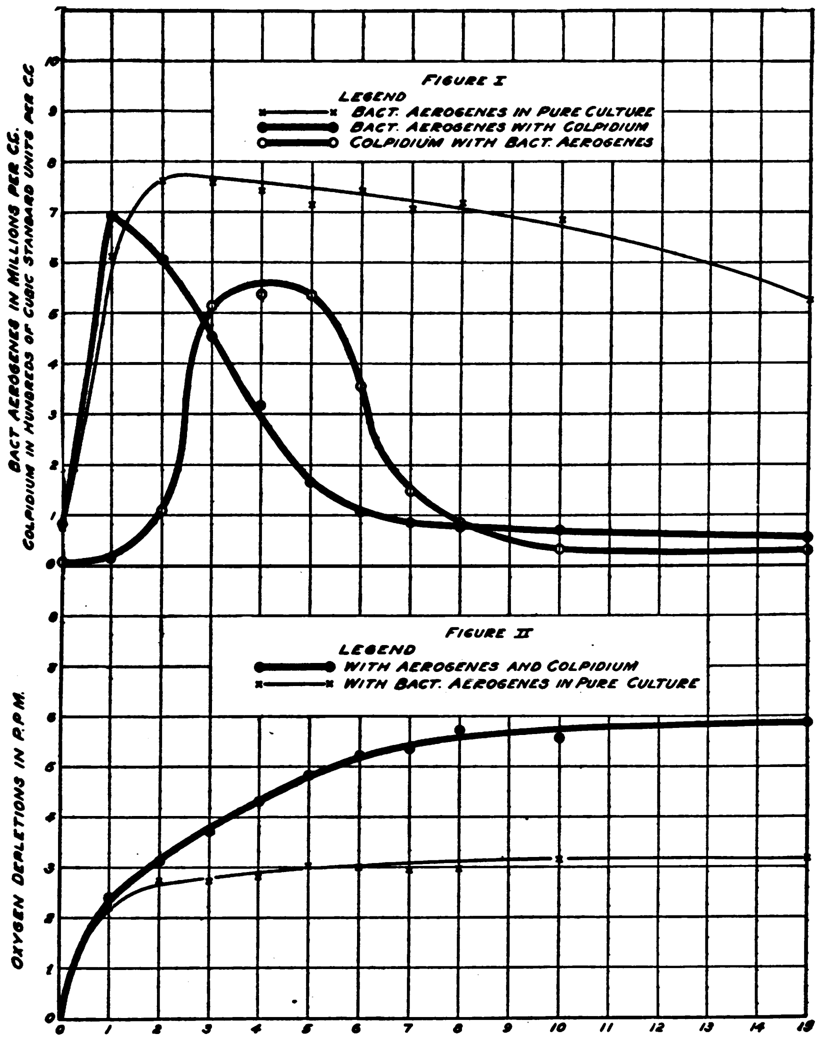

FIGURE I.—Bacteria and *Colpidium* counts in dilute dextrose-peptone solution incubated at 20° C. when inoculated with (1) *Bact. aerogenes* in pure culture and (2) *Bact. aerogenes* and *Colpidium* growing together in pure culture. Average of 10 experiments

FIGURE II.—Oxygen depletions observed in dilute dextrose-peptone solution incubated at 20° C. when inoculated with (1) *Bact. aerogenes* in pure culture and (2) *Bact. aerogenes* and *Colpidium* each in pure culture. Average of 10 experiments

dation phenomenon is obtained. As the limiting number of organisms decreases with the food supply, the numbers of *Bact. aerogenes* and of *Colpidium* decrease as the residual food supply is continuously lessened by their continuous growth.

OXIDATION BY MIXED CULTURES OF BACTERIA AND OF PLANKTON GROWING TOGETHER

Determinations were next made of the oxidation induced in the dilute medium by more complex biological cultures, using for this purpose (1) mixed cultures of bacteria with a pure culture of *Colpidium*, (2) mixed cultures of bacteria with pure cultures of other plankton, (3) complex natural flora and fauna of river water.

(1) *Mixed cultures of bacteria with a pure culture of Colpidium.*—After investigating the effect of a single species of bacteria and of plankton developing symbiotically in the dilute dextrose-peptone solution, the complexity of the biological factors was increased by putting additional bacterial species in the inoculation, with the plankton limited to *Colpidium*. Using the standardized procedure, four experiments [3] were completed with this biological combination. The results obtained are presented in Table 9.

TABLE 9.—*Bacteria and Colpidium counts and oxygen depletions observed in dilute dextrose-peptone solution incubated at 20° C., when inoculated with bacteria in mixed culture and with Colpidium*

Time, in days	Experiment No.				Average
	62	63	60	61	
A. BACTERIA PER C. C.					
0	3,870	4,010	5,350	7,900	5,280
1	8,380,000	6,720,000	4,375,000	5,250,000	6,180,000
2	5,950,000	8,600,000	7,520,000	6,620,000	7,170,000
3	4,190,000	7,900,000	6,120,000	5,800,000	6,000,000
4	[1] 2,380,000	[1] 6,000,000	5,720,000	6,420,000	5,130,000
5	585,000	4,090,000	905,000	5,580,000	2,790,000
7	505,000	1,600,000	344,000	4,040,000	1,620,000
9	725,000	1,610,000	253,000	1,040,000	907,000
10	662,000	1,630,000	130,000	422,000	711,000
15	605,000	1,620,000	68,800	266,000	640,000
B. COLPIDIUM IN CUBIC STANDARD UNITS PER C. C.					
0	2	2	5	5	4
1	9	16	5	1	8
2	446	157	47	14	166
3	1,018	1,218	310	29	644
4	[1] 1,622	[1] 1,918	760	261	1,140
5	2,225	2,618	1,369	423	1,659
7	1,075	2,062	1,280	408	1,206
9	862	1,294	1,425	396	994
10	1,975	1,285	1,010	548	1,204
15	2,874	732	1,351	534	1,373
C. OXYGEN LOSS IN P. P. M.					
1	3.37	3.16	1.84	2.85	2.80
2	3.62	3.78	2.99	4.02	3.60
3	4.43	4.30	3.26	4.37	4.09
4	[1] 4.84	[1] 4.72	3.45	4.77	4.44
5	5.24	5.14	4.54	5.82	5.18
7	5.58	5.64	5.57	6.46	5.81
9	5.68	6.38	5.92	6.83	6.20
10	6.19	6.86	5.32	6.69	6.26
15	6.82	6.94	6.29	6.92	6.74

[1] Calculated figure, mean of preceding and following results, used for average.

[3] These experiments were made in parallel with tests where the same bacteria were included in the inoculation but the plankton excluded. For these companion bacteria-only studies, reference is made to Table 4, Experiments 60, 61, 62, and 63 and the accompanying discussion

Inspection of the data presented in these tables shows that they are in good agreement with the results obtained with bacteria and plankton, each in pure culture and growing together. One difference is noted, however, namely, that the extent of deoxygenation observed is greater than has obtained in any of the previous experiments, although the medium is exactly the same. This is also in agreement with previous observations; for each time the complexity of the biological inoculation has been increased, the extent of deoxygenation also has been increased.

(2) *Mixed cultures of bacteria with pure cultures of plankton, other than Colpidium.*—While efforts to secure plankton other than *Colpidium* in bacteria-free culture were unsuccessful, as has been previously explained, and this failure prevented any study of their direct effects in bacteria-free culture, it did not prevent observations on the extent of oxidation by such plankton growing in mixed cultures of bacteria.

An experiment was conducted using the dilute dextrose-peptone solution inoculated with a very small flagellate (about 5 microns in diameter) and with bacteria. This plankton culture, prior to its use in these experiments, had been perpetuated through a large number of transfers on growths of *Bact. aerogenes*, and it is probable for this reason that all of the bacteria active in these tests were *Bact. aerogenes*. At least no other bacteria were observed. This experiment was repeated three times. The average results obtained are presented in Table 10.

In studying these results it is noted that no considerable reduction in bacterial numbers took place in the presence of the minute flagellate, such as occurred in the presence of the larger ciliate *Colpidium*. The reason for this is not known. It may be that the flagellate does not feed, or feeds to a limited extent only, on bacteria, or it may be that with this combination the biological balance was so adjusted that the death and birth rates of the bacteria were approximately the same.

TABLE 10.—*Bacteria and flagellate counts and oxygen depletions observed in dilute dextrose-peptone solution when inoculated with Bact. aerogenes and a small flagellate and incubated at 20° C. (average of three experiments)*

Time, in days	Bacteria per c. c.	Flagellates per c. c.	Oxygen depletion in p. p. m.	Time, in days	Bacteria per c. c.	Flagellates per c. c.	Oxygen depletion in p. p. m.
0	381,000	70		5	6,940,000	2,050	3.91
1	6,840,000	70	2.09	8	6,370,000	18,400	4.20
2	7,380,000	700	3.02	10	5,960,000	2,020	4.29
3	6,920,000	850	3.34	15	6,280,000	2,020	4.77

It is observed that the extent of deoxygenation was approximately the same as when the combination of *Bact. aerogenes* and *Colpidium* was used. As with *Colpidium*, the extent of deoxygenation was greater with bacteria plus flagellates than with bacteria alone. Similarly the difference became apparent only after one to two days of storage.

In attempting to determine the extent of oxidation effected by a mixed culture of bacteria and *Paramecium*, it was discovered that this plankton organism would not grow in the dilute media under any of the conditions of test. After considerable experimentation it was found that this protozoon would thrive (1) in any dilute medium with a satisfactory hydrogen ion and mineral salt content, providing very large numbers (1,000,000,000 or more per c. c.) of average-sized bacteria were added from growths [4] on solid media, and (2) in a medium sufficiently concentrated to produce naturally a bacterial maximum of 100,000,000 or more per c. c., provided this medium also contained minute suspended particles of organic material such as are found in an average domestic sewage.

Sterilized sewage affords a medium of this latter type. Sterilized sewage was accordingly inoculated with a mixed culture of bacteria which also contained *Paramecium*. Working with such a concentrated medium, it was necessary to use the aeration apparatus previously described by Theriault and Butterfield (loc. cit.) in order to maintain aerobic conditions and to determine the extent of the oxygen depletion. The sample was incubated at 20° C. and examinations were made at frequent intervals for 28 days. The results of the observations are presented in Table 11.

TABLE 11.—*Bacterial counts, Paramecium counts, and oxygen depletions observed in sterilized domestic sewage incubated at 20° C., when inoculated with a mixed culture of bacteria and with Paramecium*

Time, in days	Bacteria per c. c.	Oxygen loss in p. p. m.	Paramecium per c. c.		Time, in days	Bacteria per c. c.	Oxygen loss in p. p. m.	Paramecium per c. c.	
			Individuals	Cubic standard units				Individuals	Cubic standard units
0	92,000	----------	0.3	21	11	234,000,000	219.1	65	3,650
1	270,000,000	107.8	0	0	12	117,000,000	231.3	206	11,080
2	358,000,000	145.4	0	0	14	12,200,000	278.8	1,050	42,150
3	----------	186.2	0	0	15	6,300,000	281.9	1,790	76,970
4	310,000,000	199.8	0	0	16	2,870,000	295.5	1,450	62,350
5	----------	206.3	0	0	18	1,560,000	307.6	1,240	53,370
7	107,000,000	215.4	[1] 1	[1] 70	22	1,610,000	339.2	800	16,000
8	134,000,000	212.8	3	210	25	1,180,000	331.9	650	13,000
9	190,000,000	206.6	6	350	28	900,000	343.7	425	10,620
10	221,000,000	226.6	15	1,050					

[1] Fearing that all *Paramecium* had died out, an additional inoculation was added this day.

[4] It was necessary to add the bacterial numbers in this manner for it is not possible to produce such large numbers of bacteria in dilute media by natural multiplication in it.

While definite quantitative comparison can not be made between the results secured in this experiment with *Paramecium* and those obtained with other organisms, because the medium employed was not the same, the data are nevertheless of considerable interest because of certain similarities in the results. For instance, it is noted that during the period of increase in bacterial numbers (0 to 3 days) large amounts of oxygen were consumed. After the limiting number of bacteria had been reached and prior to the time when an increase in *Paramecium* was observed (fourth to eleventh days) very little oxygen was used up. Thereafter when *Paramecium* increased appreciably, a marked decrease in bacterial numbers occurred and extensive consumption of oxygen was again observed. The oxidation process also continued after *Paramecium* began to decline in numbers. These observations are in good agreement with those based on the studies with other organisms and tend to support the proposed theory of the rôle of the plankton in the deoxygenation process.

(3) *Results with complex natural flora and fauna of river water.*—Thus far the biological and oxygen changes occurring in the medium have been determined when it was inoculated with bacteria and with plankton, in pure culture, and with limited mixtures of the two types of life. Observations were also made of these changes when the medium was inoculated with such heterogeneous combinations of bacteria and of plankton as are normally found in polluted river water and sewage. Four such experiments, Nos. 33, 42, 44, and 45 have been completed. The procedure and the technique employed were identical with those used in the previous experiments. In experiments 33 and 45 the dilute dextrose-peptone solution containing 5.0 mg. each of dextrose and peptone per liter, was used. In experiments 42 and 44 the amounts of dextrose and peptone were increased to 50.0 mg. of each per liter of medium, which concentration required the use of the aeration method during incubation. The amount of raw river water added per liter of medium as an inoculum in each experiment was as follows: In experiment 33, 20 c. c.; in experiment 42, 5 c. c.; in experiment 44, 20 c. c.; and in experiment 45, 2 c. c.

In all cases the samples, both with the experiments carried on by the aeration procedure and by the excess oxygen dilution method, were incubated at a temperature of 20° C. The usual examinations were made at regular intervals. The results are presented in Table 12.

Table 12.—*Bacterial counts, plankton counts, and oxygen depletions observed in dextrose-peptone solution inoculated with all the bacteria and plankton in river water and incubated at 20° C.*

Time, in days	In a solution containing 50 mg. each of dextrose and peptone per liter						In a solution containing 5.0 mg. each of dextrose and peptone per liter						
	Experiment No. 42			Experiment No. 44			Experiment No. 33			Experiment No. 45			Average oxygen loss for experiments Nos. 33 and 45
	Bacteria per c. c.	Plankton [1]	Oxygen loss in p. p. m.	Bacteria per c. c.	Plankton [1]	Oxygen loss in p. p. m.	Bacteria per c. c.	Plankton [1]	Oxygen loss in p. p. m.	Bacteria per c. c.	Plankton [1]	Oxygen loss in p. p. m.	
0	50	244		2,200	4		7,460	Tr.		37,000	Tr.		
1	6,200,000	1	18.05	16,500,000	56	12.06	525,000	9	0.64	6,400,000		2.07	1.36
2	22,200,000		38.64	70,500,000	60	32.14	4,850,000	10	4.96	13,200,000		4.42	4.69
3	9,400,000	55	47.59	74,000,000		35.86	6,000,000	11	5.68	20,800,000		4.68	5.18
4	14,300,000	5,372		5,300,000	13,792	50.20				20,400,000		4.91	5.84
5	13,700,000	7,645	60.85	750,000	20,200	62.87	122,000	448	7.83	18,000,000		4.93	6.38
6	770,000	10,750	71.55	213,000	10,020	65.67	171,000	1,790	8.82	18,800,000	220	5.26	7.04
7	2,400,000	6,630	77.39				397,000	488	9.56	11,600,000	170	5.96	7.76
9		5,750	83.31	51,000	4,315	70.30	230,000	308	9.87				
10	470,000	6,100	85.00		2,780		270,000	432	10.28	21,900,000		5.40	7.84
15	125,000	665	92.52	54,000	2,004	76.50	130,000	78	10.04	2,160,000	913	8.14	9.37
20	60,000	462	96.56	13,600		76.92	36,400	78	11.27	425,000	100	9.02	10.14
25	222,000	512	98.97	6,930	6,350	80.64	18,400	113	12.07	403,000	42	9.14	10.60
30				18,800		83.46	11,400	51	11.92	369,000	76	8.74	10.33
35	45,000	275	101.30	7,900		84.24	8,560	56	12.45	725,000	82	9.56	11.00
40	24,800	384	104.90	5,350	18	86.02	8,520	27	12.18	133,000	22	9.38	10.78
45	14,600	213	102.70	9,350	220	85.72							
50	28,400	460	114.60	22,600	288		4,280	18	12.71	79,500	14	9.67	11.19
55	13,900	370	125.40	85,000	172	86.31	3,100	40	12.48				
60	21,600	180	130.40	15,800	338	88.17							
65	62,000	695	135.80	8,950		88.10	735	25	13.02	59,200	30	11.77	12.40

[1] Expressed in cubic standard units per c. c.

An inspection of these results discloses that the bacteria and plankton histories in these experiments are in good agreement with those obtained in the preceding studies when plankton were included in the bacterial inoculations added. Active multiplication of the bacteria occurred and continued until a limiting number was reached. Coincident with this limiting number an increase in the plankton content began and the bacteria decreased rapidly in numbers. Subsequently the plankton also showed a rapid decline. The biological growths were much more extensive and regular in media containing larger amounts of dextrose and peptone, as would be expected.

The oxygen depletions obtained in these experiments agreed with those in the preceding studies in all respects except one—that is, the extent of the oxygen depletions observed in the dilute dextrose-peptone solution, subjected to the activities of this more complex inoculation, was much greater than in any of the previous experiments where the inoculation added had been limited. In fact, the extent of oxidation was so great that in Experiments 33 and 45, where the test was made by the excess oxygen method, there was danger that the samples might become entirely depleted of oxygen after the sixth day of storage. To eliminate this danger the samples were removed from the incubator on the fifth day, and immediately following the examination for this day they were pooled in a common container and thoroughly aerated. The reaerated mixture was then siphoned to bottles, again examined, and returned to the 20° C. incubator.

THE INFLUENCE OF VARIATIONS IN THE COMPLEXITY OF THE BIOLOGICAL FACTORS ON THE OBSERVED OXYGEN DEPLETION

The effect of variations in the complexity of the biological factors on the life histories of the organisms present has been fairly definitely demonstrated. Attention has also been called to the variations in the oxygen depletion exhibited in a medium of constant composition resulting from the activities of the several organisms and combinations of organisms which have been tried. In order to give a better understanding of these variations in the oxygen results observed under such conditions, all of these average data have been summarized in Table 13. This table includes the average oxygen depletion figures from Tables 2, 4, 8, 9, and 12. A better conception of the differences in the rate and extent of oxidation observed, when the dilute solution was subjected to these various inoculations, may be obtained by referring to Figure 3, which has been prepared from the data presented in Table 13.

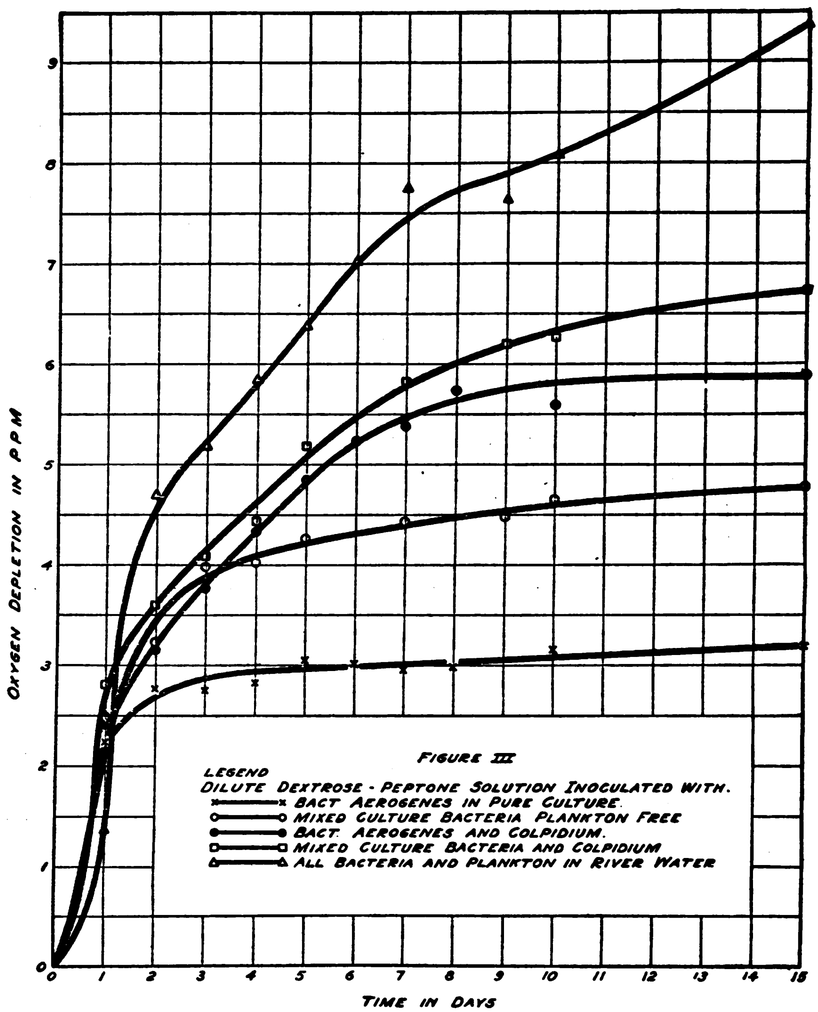

FIGURE III.—Oxygen depletions observed at 20° C. when the dilute dextrose-peptone solution was seeded with inoculations which varied in their biological complexi

TABLE 13.—*Average oxygen depletions observed at 20° C. when the dilute dextrose-peptone solution was acted upon by inoculations which varied in their biological complexity*

Time, in days	Oxygen loss with varying biological inoculations, as follows— Bact. aerogenes in pure culture	Mixed culture bacteria free from plankton	Bact. aerogenes plus Colpidium	Mixed culture bacteria plus Colpidium	All bacteria and plankton in raw river water
1	2.24	2.49	2.42	2.80	1.36
2	2.77	3.23	3.15	3.60	4.69
3	2.75	3.99	3.76	4.09	5.18
4	2.83	4.02	4.33	4.44	5.84
5	3.05	4.26	4.85	5.18	6.38
6	3.02		5.24		7.04
7	2.95	4.43	5.38	5.81	7.76
8	2.97		5.74		
9		4.48		6.20	
10	3.16	4.65	5.59	6.26	7.84
15	3.19	4.77	5.89	6.74	9.37
20					10.14
30					10.33

Judging from the results presented in this table and figure, the complexity of the inoculation introduced into the medium has but very slight effect on the rate of oxidation during the first day or two of incubation. When the extent of oxidation produced is considered, however, an entirely different condition is observed. The most simple inoculation it was possible to employ, a pure culture of bacteria, gave rise to the smallest oxygen depletion; the most complex inoculation tried, all of the organisms present in a fresh sample of river water, gave the greatest oxygen depletion. The deoxygenation produced by the other combinations of organisms tried, graded between these two extremes according to the complexity of the inoculations.

EXPERIMENTS BEARING ON THE VALIDITY OF THE PROPOSED THEORY REGARDING THE RÔLE OF THE PLANKTON

In discussing the studies presented in this paper, the theory has been advanced that the function of the plankton in the biochemical oxidation process is to maintain the bacterial population below its saturation point, or limiting number, by feeding upon the bacterial cells. It was suggested that this reduction of the bacteria permitted the remaining cells to maintain continuous multiplication and the oxidation phenomenon was continued as long as the residual food supply was sufficient to support growth. If this theory of the function of the plankton is correct, then it would follow that other methods of reducing the bacterial count below the saturation point, such as (*a*) filtration through a Berkefeld filter, (*b*) chlorination, or (*c*) partial sterilization by heat, should produce a similar effect, though not an identical one because the reduction in bacterial numbers by such procedures would be instantaneous and not continuous. Therefore, it will be of interest now to consider some experiments performed to test the validity of the theory that has been advanced to explain the action of the plankton.

(A) REDUCTION OF BACTERIAL NUMBERS BY FILTRATION THROUGH A BERKEFELD FILTER

In these experiments dilute dextrose-peptone solution, inoculated with a pure culture of *Bact. aerogenes*, was used. The standard procedure previously described was followed. The samples were incubated at 20° C. until the limiting number of bacteria had been reached. A number of bottles selected at random were then removed from the incubator and filtered through a sterile Berkefeld filter into a sterile container. A small amount of unfiltered sample was added to the sterile filtrate to restore the original inoculation. The filtrate was then shaken thoroughly to distribute the inoculation and to restore the dissolved oxygen content before it was again siphoned, with due precuation to maintain the purity of the inoculation, to sterile dissolved oxygen bottles and returned to 20° C. incubation. Immediate and subsequent examinations were made, not only to determine any change in the bacteria and dissolved oxygen contents, but also to establish the absence of any bacteria, other than *Bact. aerogenes*. Eight such experiments were performed. The individual results together with the average are presented in Table 14.

TABLE 14.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution inoculated with a pure culture of Bact. aerogenes, when the bacterial numbers have been markedly reduced by partial filtration through a Berkefeld filter, after the limiting number had been attained*

Time after filtration, in days	Experiment No.								Average
	4	5	6	7	8	14	19A	19B	
A. BACTERIA PER C. C. AFTER FILTRATION									
0	17,400	13,100	7,850	8,800	21,100	248,000	2,100	2,400	39,800
						245,000			
1	610,000	980,000	208,000	420,000	1,090,000	490,000	740,000	220,000	595,000
2	720,000	1,270,000	410,000	230,000	1,730,000	770,000	4,900,000	7,800,000	2,230,000
5	3,500,000	2,590,000	1,680,000	245,000	3,490,000	10,600,000	5,750,000	5,700,000	4,190,000
7 [1]		2,750,000	980,000	430,000	3,010,000	7,900,000	4,300,000	890,000	[1] 2,890,000
10 [2]		2,640,000	960,000	230,000	1,760,000	6,500,000	2,330,000	660,000	[2] 2,140,000
							2,280,000	520,000	
B. OXYGEN LOSS IN P. P. M. AFTER FILTRATION									
0	2.81	3.23	2.50	2.75	2.54	2.98	2.32	2.24	[3] 2.67
1	3.27	3.77	2.58	2.94	3.05	3.32	3.11	2.92	3.12
2	4.01	5.37	3.14	3.12	3.68	4.10	3.83	5.63	4.11
5		8.02	7.96	3.28	5.38	5.69	4.85	5.99	5.87
7 [1]		8.24	7.43	3.92	5.31	5.89	5.27	6.04	[1] 6.01
10 [2]		8.30	7.00+	4.50	5.65	6.47	5.45	6.32	[2] 6.24

[1] Includes results obtained at sixth to eighth days.
[2] Includes results obtained at ninth to twelfth days.
[3] Oxygen demand observed prior to filtration

These average results are also presented in Figure 4. Included in this figure are the bacterial and the oxygen depletion results (1) in the samples prior to filtration, and for purposes of comparison (2) in the control samples which were retained unfiltered.

An examination of these results shows that a secondary period of bacterial multiplication and of oxygen absorption was invariably

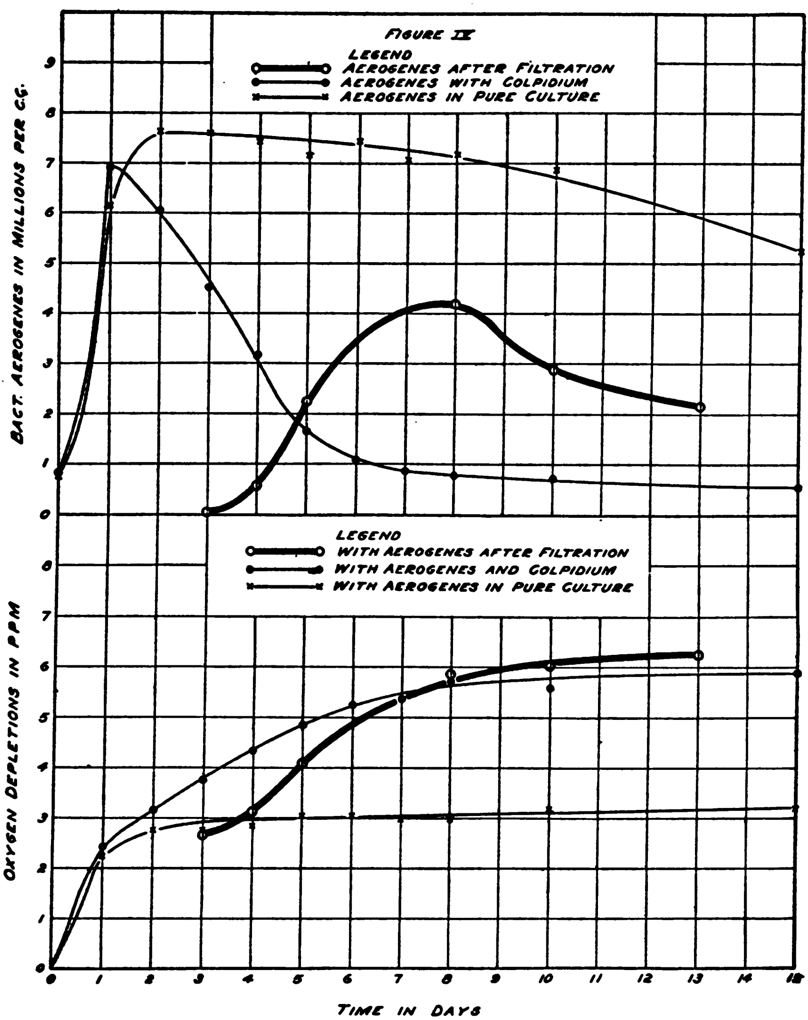

FIGURE IV.—Bacterial counts and oxygen depletions in reinoculated Berkefeld filtrate of *Bact. aerogenes* culture. Light lines give like data of unfiltered culture

observed. In fact, the average oxygen depletion obtained by this procedure is slightly in excess (6.24 as against 5.89 parts per million) of that produced by *Bact. aerogenes* and *Colpidium*, growing together in the same medium. These results tend to support the conclusion which was reached in regard to the function of the plankton.

It is recognized that filtration through the Berkefeld is a rather drastic procedure in that volatile substances may be removed and other materials may be adsorbed in the filter. However, aside from the removal of products detrimental to bacterial growth, the effect of the process would be opposed to the increased growth and resultant oxidation observed, for in filtration the tendency would be to decrease rather than to increase the concentration of food in the medium.

Two types of experiments were tried as controls on this possible effect of Berkefeld filtration—(1) filtration through hard filter paper, in which the adsorptive effect would presumably be slight, and (2) the exposure of the medium to suction, accompanied by vigorous agitation, similar to the suction applied during the filtration process.

The results obtained by filtration through hard filter paper were not satisfactory, because bacterial reductions obtained by such filtration were less than 15 per cent. Consequently, but little opportunity was offered for bacterial multiplication. Whether or not this slight reduction in bacterial numbers is all that can be expected with filtration through paper, is not known. It is possible that greater reductions were actually obtained and that multiplication of the bacteria took place during the process, for such filtration (through paper without suction) is a slow procedure requiring several hours to filter a quantity sufficient for experimental use. For these reasons no definite interpretation of the results can be made.

The experiments dealing with the application of suction without filtration were more successful. A portion of the samples, selected at random after the limiting number of bacteria had been reached, were poured into a sterile carboy and suction applied similar to that used in the filtration process. During the period of exposure to negative pressure the sample was virgorously shaken. After reaerating, the sample was again siphoned to sterile bottles for initial and subsequent examinations after incubation at 20° C. The results obtained from such an experiment are given in Table 15.

TABLE 15.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution incubated at 20° C., inoculated with a pure culture of Bact. aerogenes, when suction is applied to a portion of the sample after the limiting number of bacteria has been reached*

Time, in days	Uninterrupted sample		Suction applied on third day of storage, samples then reaerated and treated as controls	
	Bacteria per c. c.	Oxygen loss in p. p. m.	Bacteria per c. c.	Oxygen loss in p. p. m.
0	37,700	----------	----------	----------
1	5,500,000	1.99	----------	----------
3	6,300,000	2.98	5,450,000	2.98
4	6,300,000	2.95	5,700,000	2.98
5	4,750,000	3.13	5,050,000	3.48

The results indicate that the application of suction had no effect on the then present or subsequent bacterial activity and that the oxygen depletions observed did not differ significantly from those in the original samples.

(B) REDUCTION OF BACTERIAL NUMBERS BY CHLORINATION

The same medium was used and the same procedure was followed as in the tests with filtration through a Berkefeld filter. After the selected samples had been pooled, sufficient chlorine was added to give a residual of 0.8 parts per million. After mixing thoroughly, this chlorinated composite was allowed to stand thirty minutes. A sufficient quantity of unchlorinated sample was then added to the pool to reduce the chlorine content to 0.02 parts per million. It was thought that this amount would reduce the chlorine below the bactericidal concentration and at the same time would restore the original bacterial inoculation. After thorough mixing, the composite was again siphoned to sterile bottles. New examinations for bacteria and for dissolved oxygen contents were made and the remaining samples were incubated at 20° C. Table 16 contains the results which were obtained from this experiment.

TABLE 16.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution inoculated with Bact. aerogenes and incubated at 20° C. when a portion of the samples are chlorinated after the limiting number of bacteria has been reached*

Time, in days	Uninterrupted samples		Chlorinated on third day of storage; excess of chlorine removed	
	Bacteria per c. c.	Oxygen loss in p. p. m.	Bacteria per c. c.	Oxygen loss in p. p. m.
0	63,000			
1	5,400,000	1.81		
3	5,200,000	2.82	1,620,000	2.82
4	5,150,000	2.52	3,020,000	3.07
5			6,850,000	4.06
6		2.78		5.09

The results indicate that chlorination was approximately as effective as Berkefeld filtration in providing for a secondary increase in bacterial numbers with an accompanying continuation of oxygen depletion.

(C) REDUCTION OF BACTERIAL NUMBERS BY PASTEURIZATION

The dilute dextrose-peptone solution was inoculated with *Bact. aerogenes* and incubated at 20° C. for seven days. The bacterial history was followed during this period. The entire sample was then pasteurized by holding at 65° C. for one and one-half hours, cooled rapidly to 20° C., and divided into two portions. One portion was reinoculated with *Bact. aerogenes*, reaerated, and put up in sterile bottles for further study. The second portion was filtered through a Berkefeld filter to remove the dead cells of *Bact. aerogenes* and then was reinoculated, aerated, and treated in exactly the same way as the first portion. Subsequent examinations and control tests were made as in previous experiments. The results are presented in Table 17.

TABLE 17.—*Bacterial counts and oxygen depletions observed in dilute dextrose-peptone solution inoculated with Bact. aerogenes and incubated at 20° C. when the viable bacterial population is reduced by pasteurization and in one portion the dead cells removed by filtration*

Time, in days	Bacteria, per c. c. in original sample	Viable bacterial cells reduced by pasteurization and examination resumed		Viable bacterial cells reduced by pasteurization and dead cells removed by filtration. Examinations resumed	
		Bacteria per c. c.	Oxygen loss in p. p. m.	Bacteria per c. c.	Oxygen loss in p. p. m.
0	100				
1	10,000				
2	3,740,000				
3	5,500,000				
6	6,500,000				
7	6,000,000				
8		45,000		40,000	
9		236,000	0.19	940,000	0.37
10		420,000	.36	1,430,000	1.74
12		375,000	.47	1,320,000	2.16
15		235,000	.40	1,150,000	2.54

The results indicate that pasteurization was effective in reducing the number of viable bacterial cells to a minimum. However, the subsequent increase in bacterial numbers, with its accompanying oxidation, was very slight in portion 1. This was not the case in portion 2, where pasteurization was followed by filtration to remove the dead cells. Here a marked increase in bacterial numbers occurred, with a correspondingly marked increase in oxidation. This leads to the conclusion that in a medium of a given concentration the presence of a definite number of bacterial cells, living or dead, prevents further multiplication; that is, when the medium was pasteurized the cells present were killed but were preserved and remained in suspension, preventing further multiplication. A direct microscopic examination confirmed the presence of these preserved cells. In the case of chlorination this is not true; not only are the cells killed by the chlorine, but the majority of them are also actually lysed by the process and disappear. Thus, the experiments with pasteurization also tend to support the theory that the chief function of the plankton in the biochemical oxidation process is to reduce and remove the bacterial population below the saturation point and thus to provide conditions suitable for continuous multiplication.

SUMMARY

Working with a dilute dextrose-peptone solution which could be readily and accurately reproduced, a series of experiments have been performed that were designed to show the functions of the bacteria and the plankton and the probable interrelationships of the two groups of organisms in the biochemical oxidation process.

The results obtained in these experiments indicate that—

1. The dilute dextrose-peptone solution preserved free from biological activity does not absorb any dissolved oxygen under the conditions of these tests.

2. This solution, when inoculated with bacteria in pure culture, favors their growth, and they increase rapidly in numbers, reaching a limiting population by the second day of incubation. This limiting number is maintained for long periods of time.

3. While the bacteria were actively multiplying, oxygen was depleted at a rapid rate. After the limiting number had been reached, this depletion of dissolved oxygen practically ceased, although the living bacterial population remained quite high.

4. The results observed with mixed cultures of bacteria, free from plankton, were the same as with pure cultures, except that the extent of oxidation was somewhat greater.

5. The protozoon, *Colpidium* grew well in the presence of bacteria in dilute dexrose-peptone solution but was not able to grow in it in the absence of bacteria. When the concentration of food in the medium was increased 100 to 1,000 fold, *Colpidium* grew well in the absence of bacteria. The conclusion is reached that in the dilute medium the bacteria act as "collectors" or "concentrators" of the *Colpidium* food.

6. *Colpidium* growing in pure culture used up oxygen. The amount of oxygen used, however, was comparatively small.

7. When bacteria and plankton were grown together in the dilute dextrose-peptone solution, the results obtained during the first two days of incubation were approximately the same as when bacteria only were present. After the first two days, however, the bacterial numbers were not maintained but were reduced rapidly, the reduction being accompanied by a plankton increase. Moreover, the oxidation process did not cease but continued as in natural polluted waters.

8. In general it can be said that the extent of oxidation observed in the dilute dextrose-peptone solution varied directly with the complexity of the biological factors present—that is, the greater the variety of organisms acting in the medium, the more extensive the oxygen depletion observed.

Based on the results which have been obtained, the theory is advanced that the chief function of certain plankton in the biochemical

oxidation process is to keep the bacterial population reduced below the saturation point and thus to provide conditions suitable for continuous bacterial multiplication, this in turn resulting in more complete oxidation.

Support is given to this theory of the function of the plankton by the results obtained in experiments where the limiting numbers of bacteria were reduced by physical and by chemical means. Such reductions in bacterial numbers were invariably followed by renewed bacterial multiplication and oxidation.

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DEATH RATES IN A GROUP OF INSURED PERSONS

Rates for Principal Causes of Death for December, 1930, and for the Years 1911 and 1920–1930

The accompanying tables are taken from the Statistical Bulletin for January, 1931, issued by the Metropolitan Life Insurance Co. They present the mortality experience of the industrial insurance department of the company, by principal cause of death, for December, 1930, and for the years 1911 and 1920–1930, inclusive. The rates for recent years are based on a strength of approximately 19,000,000 insured persons in the United States and Canada, comprising about one-seventh of the total and about one-third of the urban population of the two countries. While this is a more or less selected group of persons and is largely urban, the death rate serves as an early index of conditions in the general population. In recent years the general death rates in this group have been averaging about 72 per cent of the death rate for the registration area of the United States.

DECEMBER, 1930

With regard to the record for December, the *Bulletin* states:

December, 1930, registered a lower death rate than any previous December. The rate was 8.4 per 1,000, as compared with 8.9 for December, 1929. While the usual seasonal increase in the mortality rate is in evidence, the rise during recent months has been more moderate than is usual for this period of the year. * * * There was more sickness than in November from influenza, measles, scarlet fever, and smallpox, but there were fewer cases of diphtheria, poliomyelitis, and typhoid fever. Compared with December, 1929, the only diseases which showed increased prevalence in 1930 were poliomyelitis and typhoid fever. These comparisons are based on the number of cases reported during the first four weeks of November and December, 1930, and December, 1929.

Death rates (annual basis) per 100,000 for principal causes of death, December, 1930

[Industrial department, Metropolitan Life Insurance Co.]

Cause of death	Rate per 100,000 lives exposed[1]				
	December, 1930	November, 1930	December, 1929	Year 1930	Year 1929
Total, all causes	844.6	765.3	886.8	870.2	934.2
Typhoid fever	2.8	2.6	2.1	2.4	2.4
Measles	1.1	.2	1.8	2.8	3.0
Scarlet fever	1.9	2.0	3.4	2.5	2.7
Whooping cough	2.8	2.3	3.3	4.3	5.7
Diphtheria	6.7	5.7	10.6	5.9	8.8
Influenza	13.2	10.7	20.9	14.7	41.9
Tuberculosis (all forms)	69.5	64.9	75.6	80.5	86.9
Tuberculosis of respiratory system	61.7	57.3	67.5	70.1	76.7
Cancer	79.1	71.3	76.6	77.9	77.6
Diabetes mellitus	17.8	16.1	17.0	18.3	18.3
Cerebral hemorrhage	63.9	55.4	[2]58.9	60.2	[2]58.0
Organic diseases of heart	146.9	130.1	147.3	144.3	146.8
Pneumonia (all forms)	75.8	66.6	89.7	75.4	88.6
Other respiratory diseases	11.6	9.3	11.0	10.9	11.7
Diarrhea and enteritis	10.6	19.0	13.0	20.3	20.8
Bright's disease (chronic nephritis)	68.4	60.7	66.9	67.8	69.4
Puerperal state	9.8	8.6	11.6	12.1	13.6
Suicides	9.4	9.6	7.6	9.7	8.5
Homicides	7.1	5.8	7.0	6.7	6.6
Other external causes (excluding suicides and homicides)	59.5	53.5	66.9	62.2	65.2
Traumatism by automobiles	21.4	21.1	21.8	20.7	21.0
All other causes	186.7	171.0	195.6	191.3	197.7

[1] All figures in this table include insured infants under one year of age. The rates for 1930 are subject to slight correction, since they are based on provisional estimates of lives exposed to risk.
[2] Rate not comparable with that for 1930.

YEAR 1930 AND COMPARISON WITH 1911 AND YEARS 1920–1929

The following is a summary of statements contained in the *Bulletin:*

The provisional general death rate in this group of persons for the year 1930 was 8.3 per 1,000, the lowest figure yet recorded. This is 6.6 per cent less than the rate for 1929, and 1.1 per cent less than that for 1927, when the previous "low" was established. If this rate reflects accurately the condition in the general populations, the health of the country as a whole, as indicated by the death rate, was probably better than for any previous year. The figure for the registration area will, therefore, be awaited with much interest.

With only a few minor exceptions, every disease showed a decided decline during the year, and a considerable number registered a new minimum. Every month but two showed a lower death rate than that for the corresponding month of the preceding year. This favorable condition is said to have prevailed not only in all sections of the United States but in Canada also. It is stated that if the 1911 rate (12.5 per 1,000) had obtained in 1930, there would have been 76,325 more deaths in this group than actually occurred. More than one-third of this saving was due to the reduced tuberculosis death rate, one-eighth to the decline in pneumonia, and one-ninth to the decline in the four principal diseases of childhood—measles, scarlet fever, whooping cough, and diphtheria. Approximately three-fourths of this saving in lives may be credited to the reduced death rate from preventable diseases during the last 20 years—the diseases which have been the chief points of attack in public-health work.

Tuberculosis.—Another reduction in the death rate for tuberculosis was an outstanding feature of the year—a reduction that has been continuous since 1911, with the exception of the years 1918 and 1926. The rate for 1930 in this group was 80.9 per 100,000, or 7.3 per cent below the previous low rate of 87.3 for 1929, and 64 per cent below that for 1911. It is noted that among the white male persons of this group the maximum tuberculosis mortality rate was at age 54 in 1929 as compared with age 39 in 1911.

Typhoid fever.—The typhoid fever death rate, 2.4 per 100,000, was identical with that for 1929—the lowest rate recorded in the records of the company. This represents a decline of nearly 90 per cent as compared with the rate of 20 years ago, a greater decline than that shown by any other disease.

Measles, scarlet fever, whooping cough, and diphtheria.—The combined mortality from these four diseases of childhood declined 26 per cent in a single year, and each of them registered a new low death rate for this group. In a brief space of three years, the diphtheria rate has been cut in half, in a single year it has been reduced more than one-third, and since 1911 it has dropped four-fifths. As an example of what it is possible to accomplish in the control of a communicable disease, diphtheria ranks next to typhoid fever.

Influenza and pneumonia.—There was no serious outbreak of influenza in 1930, and the death rate for the disease was lower than that for any year, with the exception of 1921, since the pandemic of 1918–19. The rate for pneumonia, as well as the combined rate, is the lowest ever recorded for this group.

Cancer.—In December an unusually large number of cancer deaths was more than sufficient to wipe out the slight improvement which had been noted for the year up to the close of November. The rise for the year, however, was less than 1 per cent. The death rate for cancer among these insured persons for 1930 shows an increase of 16.3 per cent over the figure for nineteen years ago.

Diabetes.—The mortality rate for diabetes, 18.6 per 100,000, is the same as that for 1929—the highest on record for this group. An upward trend has been noted for diabetes mortality for many years, but the rise during the decade just closed has been more pronounced than ever.

Principal "degenerative" diseases.—The mortality from both heart disease and chronic nephritis (Bright's disease) decreased slightly in 1930. These declines are considered to be due in large measure to the lower incidence of influenza and pneumonia.

Despite the decline in 1930, heart disease still stands far ahead as the leading cause of death, and, with the single exception of 1929, the 1930 death rate for this cause (146.4 per 100,000) was the highest ever recorded for this group. The Bulletin calls attention to the drop in the rate among children and young adults and attributes this favorable development to public health efforts, such as increased school medical inspections, growing interest in industrial hygiene in the prevention of heart disease, and the widespread preventive and therapeutic efforts being made against cardiac affections. The death rate for chronic nephritis has shown little variation for more than a decade. It was 27.5 per cent lower in 1930, however, than in 1911.

Diseases of pregnancy and childbirth.—For the third successive year a new low rate was established for puerperal diseases. The rate for 1930 was 12.3 per 100,000—a reduction of 10.9 per cent from the rate for the preceding year and of 37.9 per cent from that for 1911.

Diarrhea and enteritis.—The death rate for diarrheal complaints increased fractionally in 1930, but the *Bulletin* states that in infants under one year of age the figures for the year up to the end of September show a considerable decline from the previous minimum of 1929.

Deaths from other causes.—Deaths from alcoholism declined from 3.5 per 100,000 in 1929 to 3.2 in 1930, while the rate for cirrhosis of the liver rose from 6.6 to 6.8.

The rate for suicides increased from 8.7 per 100,000 in 1929 to 9.8 in 1930 (12.6 per cent).

The rate for automobile fatalities in this group showed a decline for the first time in 20 years. The decrease was small, however, and may not be representative of what occurred in the general population.

Death rates per 100,000 for principal causes, 1911 and 1920 to 1930, ages 1 and over

[Industrial department, Metropolitan Life Insurance Co.]

Cause of death	[1] 1930	1929	1928	1927	1926	1925	1924	1923	1922	1921	1920	1911
All causes of death	833.2	891.9	869.3	842.2	885.7	846.3	848.0	897.1	882.9	870.6	989.4	1,253.0
Typhoid fever	2.4	2.4	2.7	4.7	4.2	4.6	4.4	5.2	5.7	6.7	6.7	22.8
Communicable diseases of childhood	12.3	16.7	19.0	19.7	25.9	19.7	26.2	33.1	29.8	37.9	43.1	58.9
Measles	2.2	2.4	4.2	3.4	8.0	2.5	5.7	8.4	4.3	3.2	8.5	11.4
Scarlet fever	2.5	2.7	2.6	3.0	3.4	3.4	4.3	4.4	4.9	7.0	6.0	13.1
Whooping cough	1.9	3.0	2.7	3.1	5.0	3.6	3.5	4.8	2.6	3.9	6.6	7.1
Diphtheria	5.7	8.6	9.5	10.2	9.5	10.2	12.7	15.5	18.0	23.8	22.1	27.3
Influenza and pneumonia	75.6	111.7	94.8	78.7	105.6	88.3	84.4	107.7	95.3	76.5	159.5	131.2
Influenza	13.1	37.7	22.0	15.7	27.4	19.4	14.2	30.1	21.7	8.7	53.5	15.9
Pneumonia	62.5	74.0	72.8	63.0	78.2	69.0	70.2	77.6	73.7	67.8	106.1	115.3
Poliomyelitis	1.1	.6	1.2	2.0	.7	1.4	1.0	.7	.9	1.7	1.0	1.6
Tuberculosis, all forms	80.9	87.3	90.6	93.8	99.5	98.2	104.4	110.5	114.2	117.4	137.9	224.6
Tuberculosis of respiratory system	71.0	77.7	80.0	83.0	87.9	87.0	93.4	100.6	103.6	105.6	124.0	203.0
Cancer, all forms	79.1	78.8	77.0	75.6	75.1	71.8	71.5	72.7	72.0	71.7	69.8	68.0
Diabetes mellitus	18.6	18.6	17.9	17.1	17.0	15.5	15.1	16.2	17.2	15.5	14.1	13.3
Alcoholism	3.2	3.5	3.3	3.5	3.7	3.0	2.9	3.0	2.1	.9	.6	4.0
Cerebral hemorrhage, apoplexy	[2] 61.0	58.9	57.6	56.0	56.5	54.4	61.1	61.9	62.9	62.1	61.3	64.2
Diseases of heart [3]	146.4	149.0	144.4	134.7	136.4	128.7	125.2	128.7	126.7	117.4	117.0	141.8
Diarrhea and enteritis	8.0	7.9	8.7	9.1	10.5	12.3	11.3	11.1	10.8	14.2	15.8	28.0
Chronic nephritis (Bright's disease)	68.9	70.6	71.8	70.8	74.9	71.2	66.5	69.6	70.3	68.0	70.8	95.0
Puerperal state, total	12.3	13.8	14.2	15.7	15.6	16.9	17.2	17.9	19.0	19.8	23.0	19.8
Total external causes	78.8	80.6	77.8	79.8	77.2	78.3	76.9	77.8	71.8	72.0	72.0	97.9
Suicides	9.8	8.7	8.5	8.4	7.8	7.0	7.3	7.4	7.5	7.6	6.1	13.3
Homicides	6.8	6.7	6.8	7.4	7.2	7.4	7.2	7.3	6.3	6.7	5.8	7.2
Accidents, total	62.2	65.2	62.5	63.9	62.3	63.9	62.4	63.0	58.1	57.6	60.1	77.4
Accidental burns	4.5	4.9	5.3	5.3	6.1	6.1	6.4	6.3	6.1	6.6	8.1	8.8
Accidental drowning	5.4	6.5	7.1	6.8	6.3	6.5	7.3	6.7	7.3	8.2	6.7	10.2
Accidental traumatism by fall	9.5	9.1	8.0	8.5	7.9	8.1	7.7	8.4	7.3	7.1	7.3	13.2
Accidental traumatism by machines	1.2	1.6	1.2	1.4	1.4	1.3	1.3	1.7	1.6	1.0	1.7	1.8
Railroad accidents	3.0	3.9	3.9	4.1	4.2	4.0	4.0	4.9	4.1	3.9	5.2	9.5
Automobile accidents	21.0	21.3	18.7	18.7	17.0	16.8	15.9	15.4	13.6	12.2	11.1	2.3
All other accidents	17.6	17.8	18.3	19.1	19.4	21.2	19.7	19.5	18.1	18.6	20.0	31.6
Other diseases and conditions	184.6	191.5	188.3	181.0	183.6	183.4	180.9	181.7	185.1	190.5	197.8	283.5

[1] All 1930 death rates subject to slight correction, since they are based on provisional estimates of lives exposed to risk.

[2] Rate for 1930 not comparable with those for other years due to changes in classification procedure.

[3] Excluding pericarditis, acute endocarditis, acute myocarditis, and angina pectoris.

DEATHS DURING WEEK ENDED JANUARY 31, 1931

Summary of information received by telegraph from industrial insurance companies for the week ended January 31, 1931, and corresponding week of 1930. (From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce.)

	Week ended January 31, 1931	Corresponding week, 1930
Policies in force	75,238,098	75,447,332
Number of death claims	16,641	15,531
Death claims per 1,000 policies in force, annual rate	11.5	10.7

Deaths [1] ***from all causes in certain large cities of the United States during the week ended January 31, 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 Jan. 31, 1931				Corresponding week, 1930		Death rate [2] for the first 5 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)	10,340	15.2	800	[4] 63	13.7	829	14.2	13.1
Akron	40	8.1	6	59	9.8	9	8.0	8.6
Albany [5]	32	12.9	1	20	15.1	2	14.1	15.8
Atlanta	101	19.0	9	92	16.7	7	17.0	16.8
White	56	------	4	63	------	5	------	------
Colored	45	([6])	5	144	([6])	2	([6])	([6])
Baltimore [5]	344	22.0	17	58	14.4	19	16.8	15.2
White	240	------	12	52	------	11	------	------
Colored	104	([6])	5	78	([6])	8	([6])	([6])
Birmingham	81	15.7	8	80	17.3	9	15.3	14.0
White	38	------	4	69	------	5	------	------
Colored	43	([6])	4	97	([6])	4	([6])	([6])
Boston	281	18.7	22	63	14.8	30	17.3	15.4
Bridgeport	50	17.7	0	0	12.4	3	14.4	13.4
Buffalo	165	14.8	12	49	13.2	17	14.2	14.2
Cambridge	29	13.2	4	80	14.7	2	13.9	14.4
Camden	51	22.3	5	87	18.4	3	18.5	14.5
Canton	18	8.8	2	46	19.3	6	10.4	12.6
Chicago [5]	971	14.6	75	66	11.6	68	12.0	11.5
Cincinnati	161	18.4	9	54	19.0	16	17.8	17.0
Cleveland	184	10.5	12	35	12.6	23	11.0	12.0
Columbus	70	12.4	7	68	17.0	10	13.9	15.2
Dallas	67	12.8	8	------	15.5	5	13.2	13.9
White	55	------	7	------	------	5	------	------
Colored	12	([6])	1	------	([6])	0	([6])	([6])
Dayton	43	10.8	0	0	13.4	3	13.5	10.4
Denver	74	13.2	7	68	14.5	1	16.2	14.5
Des Moines	38	13.7	5	88	9.1	1	13.3	13.2
Detroit	250	7.9	39	62	10.8	52	8.4	9.9
Duluth	19	9.7	1	25	15.4	2	12.7	11.9
El Paso	39	19.4	9	------	18.2	3	22.8	20.9
Erie	25	11.1	4	75	14.8	4	11.1	12.1
Fall River [5,7]	31	14.0	0	0	14.9	8	12.8	12.8
Flint	27	8.6	3	38	14.5	12	8.4	9.5
Fort Worth	43	13.4	2	------	15.6	6	13.1	13.0
White	36	------	2	------	------	5	------	------
Colored	7	([6])	0	------	([6])	1	([6])	([6])
Grand Rapids	26	7.9	1	15	11.7	1	9.3	10.7
Houston	71	11.9	6	------	16.9	14	12.7	13.5
White	44	------	4	------	------	11	------	------
Colored	27	([6])	2	------	([6])	3	([6])	([6])
Indianapolis	100	14.1	7	58	19.1	7	14.5	16.8
White	88	------	6	56	------	6	------	------
Colored	12	([6])	1	67	([6])	1	([6])	([6])
Jersey City	122	19.9	21	186	12.5	7	14.6	12.4
Kansas City, Kans	35	14.8	4	82	13.7	6	15.2	13.1
White	25	------	4	98	------	6	------	------
Colored	10	([6])	0	0	([6])	0	([6])	([6])
Kansas City, Mo	116	14.8	8	61	15.5	13	14.7	14.0
Knoxville	33	15.8	4	85	18.6	4	15.2	13.9
White	27	------	3	71	------	4	------	------
Colored	6	([6])	1	204	([6])	0	([6])	([6])
Long Beach	25	8.6	0	0	13.8	1	11.1	12.2
Los Angeles	335	13.3	23	67	12.2	16	13.6	13.0
Louisville	118	20.0	11	94	18.5	4	18.7	14.8
White	87	------	9	89	------	4	------	------
Colored	31	([6])	2	133	([6])	0	([6])	([6])
Lowell [7]	33	17.1	1	25	19.7	5	15.3	14.0
Lynn	38	19.3	2	52	13.2	2	14.3	11.4
Memphis	86	17.3	10	106	15.8	8	18.7	16.3
White	46	------	7	117	------	4	------	------
Colored	40	([6])	3	87	([6])	4	([6])	([6])
Miami	34	15.8	2	51	16.9	2	13.4	12.2
White	27	------	2	71	------	1	------	------
Colored	7	([6])	0	0	([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 January 31, 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)—Continued

City	Week ended Jan. 31, 1931				Corresponding week, 1930		Death rate[2] for the first 5 weeks	
	Total deaths	Death rate[2]	Deaths under 1 year	Infant mortality rate[3]	Death rate[2]	Deaths under 1 year	1931	1930
Milwaukee	124	11.0	16	69	11.2	18	10.0	10.5
Minneapolis	102	11.2	8	52	10.6	4	12.4	12.2
Nashville	59	19.8	3	45	23.7	5	17.3	17.6
White	37		3	60		2		
Colored	22	(6)	0	0	(6)	3	(6)	(6)
New Bedford[7]	24	11.1	1	27	8.8	2	13.1	11.6
New Haven	42	13.5	0	0	16.3	2	13.3	14.6
New Orleans	195	21.7	11	60	22.0	24	21.6	20.8
White	133		6	50		8		
Colored	62	(6)	5	81	(6)	16	(6)	(6)
New York	2,215	16.3	173	72	12.1	140	15.0	11.8
Bronx Borough	311	12.2	18	41	9.0	17	10.8	8.3
Brooklyn Borough	801	15.9	78	83	11.1	58	14.2	10.9
Manhattan Borough	788	22.6	59	101	18.1	51	22.4	17.7
Queens Borough	259	11.7	17	46	7.5	12	10.1	7.8
Richmond Borough	56	17.9	1	18	12.8	2	14.9	13.8
Newark, N. J.	143	16.7	13	68	14.6	11	14.1	14.0
Oakland	64	11.4	4	51	12.4	2	13.4	13.3
Oklahoma City	41	10.9	3	41	9.7	3	11.5	9.8
Omaha	66	15.9	9	101	21.1	7	15.6	15.2
Paterson	53	19.9	5	86	11.3	4	14.6	12.3
Philadelphia	728	19.3	46	67	13.3	31	16.8	13.2
Pittsburgh	225	17.4	26	90	17.1	25	16.9	14.7
Portland, Oreg.	68	11.5	1	12	14.6	2	13.8	14.4
Providence	89	18.2	7	65	17.3	3	15.8	16.0
Richmond	65	18.4	6	87	16.5	10	16.6	16.3
White	40		3	66		5		
Colored	25	(6)	3	130	(6)	5	(6)	(6)
Rochester	92	14.5	4	36	12.4	6	13.4	11.8
St. Louis	280	17.6	16	54	15.5	10	16.8	14.7
St. Paul	64	12.1	3	31	12.1	5	11.2	12.1
Salt Lake City[5]	29	10.6	2	30	19.6	6	13.9	14.9
San Antonio	80	17.4	11		23.2	17	16.3	21.4
San Diego	51	17.0	3	61	14.6	2	16.9	16.5
San Francisco	180	14.4	5	33	13.7	10	15.4	14.3
Schenectady	22	11.9	0	0	11.4	4	9.5	11.1
Seattle	88	12.3	5	47	15.2	7	13.2	11.2
Somerville	21	10.4	0	0	13.5	4	10.4	12.6
South Bend	14	6.8	3	75	9.4	2	7.7	9.6
Spokane	32	14.3	2	52	12.2	0	14.7	13.0
Springfield, Mass.	51	17.5	4	61	19.1	4	13.6	14.0
Syracuse	62	15.2	6	71	12.7	4	13.4	13.3
Tacoma	25	12.1	0	0	10.2	2	15.1	11.0
Toledo	73	12.9	5	46	15.0	4	12.5	13.8
Trenton	50	21.1	6	104	19.4	4	19.6	17.5
Utica	29	14.8	2	52	12.8	3	16.8	15.9
Washington, D. C.	181	19.1	7	39	17.1	10	18.5	16.3
White	110		3	25		5		
Colored	71	(6)	4	69	(6)	5	(6)	(6)
Waterbury	25	12.9	2	60	12.5	2	10.5	10.4
Wilmington, Del.[7]	37	18.1	5	108	21.0	7	15.4	15.4
Worcester	70	18.5	3	41	13.6	5	15.5	14.0
Yonkers	38	14.3	2	52	8.5	2	11.2	8.3
Youngstown	37	11.2	5	70	13.8	5	11.1	10.9

[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 February 7, 1931, and February 8, 1930

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended February 7, 1931, and February 8, 1930

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930
New England States:								
Maine	4	5	38	5	10	12	0	1
New Hampshire	2	3	104	1	132	58	0	0
Vermont	1		6			2	0	0
Massachusetts	65	118	197	2	633	323	3	2
Rhode Island	8	8	21			2	0	0
Connecticut	10	24	182	9	257	24	1	2
Middle Atlantic States:								
New York	106	139	[1] 226	[1] 53	592	534	12	17
New Jersey	62	120	475	16	663	323	8	4
Pennsylvania	120	136			1,544	730	7	3
East North Central States:								
Ohio	57	42	43	16	217	570	6	6
Indiana	59	43	149		459	55	5	31
Illinois	153	161	359	46	980	433	10	19
Michigan	45	64	13	7	191	374	8	22
Wisconsin	21	19	143	22	295	1,058	1	3
West North Central States:								
Minnesota	16	15	5	1	39	247	1	2
Iowa	8	4			11	461	6	9
Missouri	48	36	84	33	899	52	8	18
North Dakota	6	3			1	54	0	0
South Dakota	5	1			8	77	1	0
Nebraska	9	14			6	599	2	6
Kansas	23	15	12	7	16	352	3	7
South Atlantic States:								
Delaware		2	56	2	7	3	0	0
Maryland [2]	21	35	1,625	51	322	8	0	2
District of Columbia	12	13	48	1	47	6	0	0
Virginia							1	6
West Virginia	10	12	111	70	33	85	0	2
North Carolina	36	32	462	44	183	5	5	2
South Carolina [3]	25	26	3,147	1,214	118		0	5
Georgia	7	4	806	121	145		4	12
Florida	8	13	278	7	167	39	3	0

[1] New York City only.
[2] Week ended Friday.
[3] Typhus fever, 1931, 1 case in South Carolina.

***Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended February 7, 1931, and February 8, 1930*—Continued**

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930
East South Central States:								
Kentucky					97	96	3	0
Tennessee	3	10	185	201	212	147	5	1
Alabama	31	27	233	209	519	63	4	5
Mississippi	17	23					1	7
West South Central States:								
Arkansas	9	3	159	212	6	6	2	3
Louisiana	37	25	220	71	3	73	2	6
Oklahoma [4]	47	28	236	183	42	306	0	8
Texas	76	77	151	267	100	105	1	7
Mountain States:								
Montana		1			5	18	0	1
Idaho		1	3		1	99	0	5
Wyoming				4	2	37	1	1
Colorado	12	10		1	112	101	2	2
New Mexico	6	5	1		51	116	0	5
Arizona	8	8	12	17	203	6	4	4
Utah [3]	2	1	10		2	88	1	5
Pacific States:								
Washington	12	15			67	312	1	9
Oregon	5	7	32	84	98	29	2	2
California	49	62	236	63	676	943	10	12

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930
New England States:								
Maine	0	1	33	71	0	0	2	5
New Hampshire	0	0	1	18	0	0	0	0
Vermont	0	0	1	6	0	3	0	1
Massachusetts	1	1	357	310	0	0	4	5
Rhode Island	0	0	39	38	0	0	0	0
Connecticut	0	0	53	135	0	0	0	0
Middle Atlantic States:								
New York	0	4	789	529	8	6	8	15
New Jersey	0	1	256	241	0	0	5	5
Pennsylvania	1	0	567	475	1	8	13	13
East North Central States:								
Ohio	1	3	499	278	[illegible]	242	13	16
Indiana	0	0	345	294	105	247	0	7
Illinois	4	2	472	661	68	128	2	6
Michigan	0	0	331	317	48	100	4	5
Wisconsin	0	1	182	144	3	42	5	5
West North Central States:								
Minnesota	2	0	110	161	9	8	3	3
Iowa	1	1	147	103	64	107	0	1
Missouri	0	0	223	150	34	75	5	1
North Dakota	0	0	42	38	21	40	2	0
South Dakota	1	1	28	30	25	49	1	2
Nebraska	1	0	50	101	69	40	3	0
Kansas	0	0	61	177	118	97	5	1
South Atlantic States:								
Delaware	0	0	23	16	0	0	0	0
Maryland [2]	0	0	105	94	0	0	6	4
District of Columbia	0	0	37	12	0	0	0	4
Virginia	1							
West Virginia	0	0	48	48	21	20	2	5
North Carolina	1	0	86	72	5	17	2	1
South Carolina [3]	0	0	13	24	2	1	7	1
Georgia	0	0	55	24	0	0	6	1
Florida	0	0	8	19	0	1	2	3
East South Central States:								
Kentucky	0	0	97	65	8	17	2	6
Tennessee	0	0	48	49	3	15	5	2
Alabama	0	0	36	34	5	2	5	2
Mississippi	1	0	39	22	21	6	7	5

[2] Week ended Friday.
[3] Typhus fever, 1931, 1 case in South Carolina.
[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 February 7, 1931, and February 8, 1930—Continued

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930	Week ended Feb. 7, 1931	Week ended Feb. 8, 1930
West South Central States:								
Arkansas	1	0	17	20	38	12	1	5
Louisiana	2	0	24	22	10	3	15	6
Oklahoma [4]	1	0	30	54	113	103	2	3
Texas	0	2	92	94	290	227	22	1
Mountain States:								
Montana	0	0	54	60	7	13	1	0
Idaho	0	0	3	5	1	12	1	1
Wyoming	0	0	7	5	1	1	1	0
Colorado	0	0	49	24	15	57	0	1
New Mexico	0	0	7	9	2	1	0	3
Arizona	0	0	7	8	1	19	1	0
Utah [2]	0	0	6	9	0	0	0	0
Pacific States:								
Washington	1	0	84	86	46	92	0	7
Oregon	2	1	31	67	32	17	0	5
California	6	0	110	340	69	109	5	6

[2] Week ended Friday. [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
December, 1930										
Kansas	4	112	4		26		4	222	226	13
Mississippi	7	134	3,052	1,270	142	283	2	133	30	46
January, 1931										
Arizona	23	34	54		379		1	28	15	4
Connecticut	5	55	384	1	1,044		0	265	0	2
Georgia	37	71	1,029	85	382	28	1	246	15	19
Nebraska	6	39	84		84		9	230	288	6
North Dakota	10	23	13		21		5	145	44	4
Wyoming	5	2	2		4		2	106	3	0

December, 1930

	Cases
Chicken pox:	
Kansas	717
Mississippi	579
Conjunctivitis:	
Kansas	2
Dysentery:	
Mississippi (amebic)	17
Mississippi (bacillary)	166
German measles:	
Kansas	6
Hookworm disease:	
Mississippi	151
Impetigo contagiosa:	
Kansas	1
Mumps:	
Kansas	78
Mississippi	161
Ophthalmia neonatorum:	
Kansas	1
Mississippi	10
Paratyphoid fever:	
Kansas	2
Puerperal septicemia:	
Mississippi	22
Rabies in animals:	
Mississippi	4
Scabies:	
Kansas	10
Tetanus:	
Kansas	2
Trachoma:	
Mississippi	14
Tularaemia:	
Kansas	5
Undulant fever:	
Kansas	6

	Cases
Vincent's angina:	
Kansas	7
Whooping cough:	
Kansas	118
Mississippi	624

January, 1931

	Cases
Anthrax:	
Connecticut	1
Chicken pox:	
Arizona	57
Connecticut	577
Georgia	180
Nebraska	340
North Dakota	169
Wyoming	183
Conjunctivitis:	
Connecticut	28
Dysentery:	
Arizona	1
Georgia	8
German measles:	
Connecticut	25
Hookworm disease:	
Georgia	20
Lethargic encephalitis:	
Connecticut	3
Mumps:	
Arizona	26
Connecticut	380
Georgia	116
Nebraska	278
North Dakota	60
Mumps—Continued.	
Wyoming	89
Rabies in animals:	
Connecticut	6
Rabies in man:	
Georgia	1
Septic sore throat:	
Connecticut	11
Georgia	51
North Dakota	1
Tetanus:	
North Dakota	1
Trachoma:	
Arizona	8
North Dakota	4
Trichinosis:	
Connecticut	1
Typhus fever:	
Georgia	15
Undulant fever:	
Arizona	1
Connecticut	2
Vincent's angina:	
North Dakota	47
Wyoming	2
Whooping cough:	
Arizona	15
Connecticut	279
Georgia	112
Nebraska	129
North Dakota	73
Wyoming	68

GENERAL CURRENT SUMMARY AND WEEKLY REPORTS FROM CITIES

The 96 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 33,315,000. The estimated population of the 89 cities reporting deaths is more than 31,775,000. The estimated expectancy is based on the experience of the last nine years, excluding epidemics.

Weeks ended January 31, 1931, and February 1, 1930

	1931	1930	Estimated expectancy
Cases reported			
Diphtheria:			
46 States	1,404	1,619	
96 cities	567	705	962
Measles:			
45 States	8,853	8,101	
96 cities	2,681	1,751	
Meningococcus meningitis:			
47 States	155	232	
96 cities	75	95	
Poliomyelitis:			
46 States	36	20	
Scarlet fever:			
46 States	5,884	5,422	
96 cities	2,155	1,828	1,528
Smallpox:			
46 States	1,031	1,628	
96 cities	111	196	55
Typhoid fever:			
46 States	166	129	
96 cities	31	31	38
Deaths reported			
Influenza and pneumonia:			
89 cities	2,006	1,083	
Smallpox:			
89 cities	0	0	

City reports for week ended January 31, 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 nonepidemic 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	11	1	0	13	1	2	7	3
New Hampshire:								
Concord	0	0	0	--------	0	1	0	0
Manchester	0	1	0	--------	1	17	0	0
Nashua	0	0	1	--------	0	0	0	0
Vermont:								
Barre	0	0	0	--------	1	0	0	1
Burlington	0	1	0	--------	0	0	0	0
Massachusetts:								
Boston	66	36	23	149	5	68	15	17
Fall River	2	5	4	2	0	2	5	1
Springfield	16	5	2	1	1	1	7	1
Worcester	2	4	5	19	2	7	0	17
Rhode Island:								
Pawtucket	8	2	0	--------	0	0	0	2
Providence	4	10	4	17	1	1	0	5
Connecticut:								
Bridgeport	0	6	1	26	1	2	1	9
Hartford	7	6	4	14	0	52	1	11
New Haven	12	0	1	11	2	46	17	10
MIDDLE ATLANTIC								
New York:								
Buffalo	39	13	9	5	1	47	78	30
New York	264	206	89	646	142	206	33	535
Rochester	5	8	2	3	1	0	1	4
Syracuse	57	3	1	--------	1	9	0	5
New Jersey:								
Camden	6	7	5	14	7	88	8	11
Newark	72	21	11	163	4	5	6	33
Trenton	8	2	3	129	1	2	1	4
Pennsylvania:								
Philadelphia	177	69	18	198	61	127	20	141
Pittsburgh	91	22	11	18	9	62	22	58
Reading	8	2	2	--------	0	138	36	3
EAST NORTH CENTRAL								
Ohio:								
Cincinnati	9	9	4	7	1	57	30	18
Cleveland	147	33	19	40	4	5	183	12
Columbus	15	3	4	5	6	3	8	6
Toledo	49	6	3	--------	0	1	28	7
Indiana:								
Fort Wayne	3	5	5	--------	0	40	0	1
Indianapolis	46	9	4	--------	3	23	2	12
South Bend	--------	1	--------	--------	--------	--------	--------	--------
Terre Haute	0	1	0	--------	0	0	0	1
Illinois:								
Chicago	90	107	98	411	38	32	66	173
Springfield	15	1	4	3	1	38	0	8
Michigan:								
Detroit	108	52	36	37	2	6	23	33
Flint	27	2	3	7	0	4	0	2
Grand Rapids	3	1	0	--------	0	1	0	1

City reports for week ended January 31, 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	16	0	0		0	0	15	0
Madison	68	1	5			4	32	
Milwaukee	132	18	4	8	4	24	264	20
Racine	10	2	0	8	0	1	1	0
Superior	7	1	0		0	0	0	1
WEST NORTH CENTRAL								
Minnesota:								
Duluth	15	0	0		1	0	4	1
Minneapolis	38	22	3		2	35	96	8
St. Paul	39	5	0	1	1	5	0	9
Iowa:								
Des Moines	3	2	1			0	1	
Sioux City	11	1	3			0	8	
Waterloo	6	1	0			0	0	
Missouri:								
Kansas City	48	5	12	1	0	41	0	14
St. Joseph	6	1	9		2	0	0	3
St. Louis	29	43	26	33	1	712	21	
North Dakota:								
Fargo	9	0	0		0	0	5	1
Grand Forks	3	0	0			0	4	
South Dakota:								
Aberdeen	0	0	0			0	1	
Sioux Falls	0	0	0			0	0	
Nebraska:								
Omaha	21	5	4		0	1	10	9
Kansas:								
Topeka	0	2	0	1	3	1	0	2
Wichita	4	4	0		0	0	0	7
SOUTH ATLANTIC								
Delaware:								
Wilmington	0	3	1		2	3	0	7
Maryland:								
Baltimore	180	24	14	2,053	19	232	44	66
Cumberland	0	0	0	11	0	1	0	2
Frederick	0	0	0		0	0	5	0
District of Columbia:								
Washington	50	20	11	52	12	27	0	32
Virginia:								
Lynchburg	8	1	0		1	2	0	1
Norfolk	13	2	1	289	2	1	0	11
Richmond	0	5	7	33	6	134	0	11
Roanoke	10	2	0		4	0	0	0
West Virginia:								
Charleston	3	1	0	2	1	0	2	1
Wheeling	15	1	0	1	0	0	0	3
North Carolina:								
Raleigh	3	1	0		0	2	0	3
Wilmington	19	0	0		2	0	0	0
Winston-Salem	5	0	0	137	3	5	1	15
South Carolina:								
Charleston	3	2	0	239	3	22	6	8
Columbia		1						
Greenville	0	0	1		0	1	0	0
Georgia:								
Atlanta	0	5	2	115	5	39	0	15
Brunswick	0	0	0		0	0	0	0
Savannah	2	1	1	108	4	0	3	4
Florida:								
Miami	0	2	0	1	0	0	0	1
Tampa	11	2	0	4	1	45	1	3
EAST SOUTH CENTRAL								
Kentucky:								
Covington	0	0	1		0	0	1	2
Tennessee:								
Memphis	73	5	4		5	9	11	9
Nashville	0	1	0		4	13	0	8

City reports for week ended January 31, 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	2	4	4	8	3	133	4	13
Mobile	1	0	2	74	0	1	0	4
Montgomery	30	1	1	7	----------	0	0	----------
WEST SOUTH CENTRAL								
Arkansas:								
Forth Smith	0	0	1	----------	----------	1	0	----------
Little Rock	1	1	0	----------	0	1	4	0
Louisiana:								
New Orleans	1	15	34	16	17	0	0	15
Shreveport	8	1	1	----------	1	0	2	9
Oklahoma:								
Muskogee	1	1	0	6	0	0	0	1
Oklahoma City	2	2	3	20	1	5	0	12
Tulsa	10	2	1	----------	----------	1	1	----------
Texas:								
Dallas	25	7	5	5	6	2	5	8
Fort Worth	9	4	2	----------	0	0	0	6
Galveston	0	1	0	----------	0	0	0	6
Houston	11	8	10	----------	0	0	2	6
San Antonio	3	4	3	----------	5	1	0	15
MOUNTAIN								
Montana:								
Billings	4	0	0	----------	0	0	0	1
Great Falls	4	1	0	----------	1	0	0	0
Helena	0	0	0	----------	0	0	0	0
Missoula	0	0	0	----------	0	0	0	0
Idaho:								
Boise	0	0	0	----------	0	0	0	0
Colorado:								
Denver	46	9	8	----------	2	17	0	14
Pueblo	2	2	0	----------	1	39	4	1
New Mexico:								
Albuquerque	0	0	0	1	0	0	0	3
Arizona:								
Phoenix	0	1	0	----------	0	0	2	2
Utah:								
Salt Lake City	11	3	0	----------	2	1	3	6
Nevada:								
Reno	0	0	0	----------	0	0	0	1
PACIFIC								
Washington:								
Seattle	21	4	2	----------	----------	2	33	----------
Spokane	15	3	0	----------	----------	13	0	----------
Tacoma	12	3	1	----------	0	1	0	2
Oregon:								
Portland	24	9	0	2	1	6	10	0
Salem	0	1	0	----------	0	11	18	0
California:								
Los Angeles	88	43	12	100	2	36	9	30
Sacramento	16	2	2	1	1	1	3	10
San Francisco	55	15	6	14	3	3	4	6

City reports for week ended January 31, 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	4	15	0	0	0	0	0	0	0	27	18
New Hampshire:											
Concord	0	0	0	0	0	0	0	0	0	0	8
Manchester	2	3	0	0	0	0	0	0	0	0	27
Nashua	2	0	0	0	0	0	0	0	0	0	--------
Barre	0	2	0	0	0	2	0	0	0	4	9
Burlington	2	0	0	0	0	0	0	0	0	0	7
Massachusetts:											
Boston	84	104	0	0	0	12	0	2	0	46	281
Fall River	4	15	0	0	0	3	0	0	0	8	31
Springfield	10	7	0	0	0	1	0	0	0	0	51
Worcester	11	21	0	0	0	1	0	0	0	12	70
Rhode Island:											
Pawtucket	2	23	0	0	0	1	1	0	0	0	16
Providence	13	18	0	0	0	5	0	0	0	2	89
Connecticut:											
Bridgeport	10	5	0	0	0	5	0	0	0	1	50
Hartford	7	4	0	0	0	1	0	0	0	4	50
New Haven	8	2	0	0	0	1	0	0	0	3	42
MIDDLE ATLANTIC											
New York:											
Buffalo	26	34	1	0	0	3	0	0	0	5	161
New York	258	283	1	0	0	110	8	3	0	140	2,215
Rochester	9	109	0	0	0	0	0	0	0	21	84
Syracuse	15	9	0	0	0	2	1	0	1	20	62
New Jersey:											
Camden	8	6	0	0	0	0	0	0	0	1	51
Newark	43	33	0	0	0	10	0	0	0	36	146
Trenton	6	15	0	0	0	4	0	0	0	0	50
Pennsylvania:											
Philadelphia	107	184	0	0	0	46	2	1	1	17	728
Pittsburgh	37	58	0	0	0	7	1	0	0	40	225
Reading	4	3	0	0	0	2	0	0	0	0	30
EAST NORTH CENTRAL											
Ohio:											
Cincinnati	22	37	0	1	0	10	1	0	0	7	161
Cleveland	47	77	0	0	0	13	1	0	0	17	184
Columbus	12	12	0	0	0	7	1	0	1	0	70
Toledo	15	14	0	4	0	7	0	1	0	4	73
Indiana:											
Fort Wayne	6	7	0	4	0	1	0	0	0	1	24
Indianapolis	12	78	4	24	0	3	0	0	0	41	--------
South Bend	4	--------	1	--------	--------	--------	0	--------	--------	--------	--------
Terre Haute	4	8	1	0	0	0	0	0	0	2	13
Illinois:											
Chicago	138	259	2	5	0	41	5	0	0	68	971
Springfield	3	4	0	0	0	0	1	0	0	1	31
Michigan:											
Detroit	117	86	2	2	0	14	1	1	0	71	250
Flint	15	11	1	1	0	0	0	0	0	6	27
Grand Rapids	13	8	0	2	0	1	0	0	0	8	26
Wisconsin:											
Kenosha	2	3	0	1	0	0	0	0	0	0	10
Madison	4	2	0	0	--------	--------	0	0	--------	6	--------
Milwaukee	39	19	1	0	0	6	0	1	0	25	124
Racine	5	5	0	0	0	1	0	0	0	3	11
Superior	3	3	0	0	0	0	0	0	0	8	8

City reports for week ended January 31, 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											
Minnesota:											
Duluth	11	1	0	0	0	0	0	0	0	5	19
Minneapolis	54	15	3	2	0	3	1	4	0	8	102
St. Paul	35	5	1	0	0	2	1	1	0	13	64
Iowa:											
Des Moines	11	7	2	3	-------	-------	0	0	-------	2	38
Sioux City	1	20	1	1	-------	-------	0	0	-------	0	-------
Waterloo	3	0	0	0	-------	-------	0	0	-------	2	-------
Missouri:											
Kansas City	19	12	1	0	0	6	0	0	0	0	116
St. Joseph	3	8	0	0	0	0	0	0	0	0	35
St. Louis	38	126	1	2	0	15	0	2	0	17	280
North Dakota:											
Fargo	3	6	0	0	0	0	0	0	0	3	7
Grand Forks	0	0	1	0	-------	-------	0	0	-------	0	-------
South Dakota:											
Aberdeen	1	1	0	1	-------	-------	0	0	-------	0	-------
Sioux Falls	2	0	0	5	-------	-------	0	0	-------	0	9
Nebraska:											
Omaha	5	8	1	20	0	1	0	0	0	5	66
Kansas:											
Topeka	3	1	1	0	0	0	0	0	0	0	17
Wichita	6	0	0	19	0	2	0	0	0	2	40
SOUTH ATLANTIC											
Delaware:											
Wilmington	6	9	0	0	0	1	0	0	0	1	37
Maryland:											
Baltimore	39	53	0	0	0	21	2	0	0	16	344
Cumberland	1	3	0	0	0	1	0	0	0	0	14
Frederick	1	1	0	0	0	0	0	0	0	0	4
District of Col.:											
Washington	26	26	0	0	0	7	1	1	0	7	181
Virginia:											
Lynchburg	0	1	0	0	0	0	0	0	0	0	11
Norfolk	3	2	0	0	0	2	0	0	0	5	-------
Richmond	5	13	0	0	0	5	0	0	0	3	73
Roanoke	1	1	0	0	0	1	0	0	0	0	23
West Virginia:											
Charleston	0	0	0	0	0	0	0	1	0	0	10
Wheeling	2	0	0	0	0	0	1	0	0	0	17
North Carolina:											
Raleigh	0	0	0	0	0	1	0	0	0	5	13
Wilmington	1	1	0	0	0	0	0	0	0	2	13
Winston-Salem	2	0	1	0	0	4	0	0	0	0	36
South Carolina:											
Charleston	1	0	0	0	0	2	0	0	0	0	33
Columbia	0	-------	1	-------	-------	-------	0	-------	-------	-------	-------
Greenville	1	1	0	0	0	0	0	0	0	0	-------
Georgia:											
Atlanta	6	44	2	0	0	12	0	2	1	2	101
Brunswick	0	0	0	0	0	1	0	0	0	0	5
Savannah	1	0	0	0	0	3	0	0	0	0	31
Florida:											
Miami	1	0	0	0	0	0	0	0	0	5	34
Tampa	1	3	0	0	0	2	1	0	0	0	24
EAST SOUTH CENTRAL											
Kentucky:											
Covington	2	11	0	0	0	2	0	1	0	0	37
Tennessee:											
Memphis	7	50	1	2	0	10	0	1	1	1	86
Nashville	2	7	0	0	0	4	0	1	0	0	59
Alabama:											
Birmingham	4	15	1	0	0	2	1	0	0	3	81
Mobile	1	2	0	1	0	2	0	0	0	0	28
Montgomery	0	3	0	0	-------	-------	0	0	-------	0	-------

City reports for week ended January 31, 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 SOUTH CENTRAL											
Arkansas:											
Fort Smith	1	1	0	0			0	0		1	
Little Rock	1	1	0	0	0	1	0	0	0	0	
Louisiana:											
New Orleans	8	19	0	3	0	17	3	1	0	1	196
Shreveport	1	1	0	0	0	0	0	0	0	0	32
Oklahoma:											
Muskogee	1	0	2	0	0	0	0	0	0	1	
Oklahoma City	3	4	1	3	0	4	0	1	0	0	41
Tulsa	2	5	2	5			0	0		0	1
Texas:											
Dallas	6	8	2	0	0	4	0	0	0	2	67
Fort Worth	3	4	1	2	0	4	0	1	0	0	43
Galveston	0	0	0	1	0	0	1	2	0	0	23
Houston	4	2	2	11	0	5	0	1	0	0	71
San Antonio	1	1	0	0	0	8	0	0	0	0	80
MOUNTAIN											
Montana:											
Billings	1	0	0	0	0	0	0	0	0	6	8
Great Falls	3	5	0	0	0	0	0	0	0	8	7
Helena	1	0	0	0	0	0	0	0	0	0	5
Missoula	1	0	0	0	0	1	0	0	0	0	3
Idaho:											
Boise	0	0	0	0	0	0	0	0	0	0	3
Colorado:											
Denver	14	28	1	0	0	6	0	0	0	17	80
Pueblo	2	0	0	0	0	1	0	0	0	4	7
New Mexico:											
Albuquerque	1	0	0	0	0	2	0	0	0	1	7
Arizona:											
Phoenix	0	1	0	0	0	1	0	0	0	3	
Utah:											
Salt Lake City	5	4	1	0	0	2	0	0	0	27	29
Nevada:											
Reno	0	0	0	0	0	0	0	0	0	0	4
PACIFIC											
Washington:											
Seattle	11	12	3	1			1	1		27	
Spokane	7	4	7	3			0	0		0	
Tacoma	3	5	4	1	0	0	0	0	0	1	25
Oregon:											
Portland	6	4	12	18	0	1	0	0	0	0	68
Salem	0	0	1	0	0	0	0	0	0	0	
California:											
Los Angeles	43	45	4	2	0	23	2	0	0	21	335
Sacramento	2	0	1	1	0	3	0	[1] 3	0	13	37
San Francisco	23	7	2	1	0	11	0	1	0	30	169

[1] Non residents.

City reports for week ended January 31, 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
NEW ENGLAND									
Massachusetts:									
Boston	1	0	0	0	0	0	1	1	0
Worcester	0	0	0	0	0	0	0	1	0
Connecticut:									
Bridgeport	0	0	1	0	0	0	0	0	0
MIDDLE ATLANTIC									
New York:									
New York [1]	23	17	2	3	0	0	1	0	0
Rochester	1	0	0	0	0	0	0	0	0
New Jersey:									
Newark	2	1	0	0	0	0	0	0	0
Pennsylvania:									
Philadelphia	8	1	1	0	0	0	0	1	0
Pittsburgh	1	1	1	1	0	0	0	1	0
EAST NORTH CENTRAL									
Ohio:									
Cincinnati	2	1	0	0	0	0	0	0	0
Cleveland	2	0	1	0	0	0	0	0	0
Indiana:									
Indianapolis	2	1	0	0	0	0	0	1	0
Illinois:									
Chicago	6	4	0	0	0	0	0	1	0
Michigan:									
Detroit	6	3	1	0	0	0	0	0	0
WEST NORTH CENTRAL									
Minnesota:									
St. Paul	0	0	0	0	0	0	0	0	1
Iowa:									
Waterloo	1	1	0	0	0	0	0	0	0
Missouri:									
Kansas City	3	1	0	0	0	0	0	1	0
St. Louis	1	0	0	0	0	0	0	0	0
SOUTH ATLANTIC [1]									
Maryland:									
Baltimore	0	0	0	1	0	0	0	0	0
District of Columbia:									
Washington	3	1	0	0	0	0	0	0	0
North Carolina:									
Wilmington	0	0	0	0	0	1	0	0	0
South Carolina:									
Charleston	0	0	0	0	4	0	0	0	0
Georgia: [1]									
Atlanta	0	1	0	0	0	0	0	0	0
Brunswick	0	0	0	0	0	1	0	0	0
EAST SOUTH CENTRAL									
Tenessee:									
Memphis	3	1	0	0	0	1	0	0	0
Alabama:									
Birmingham	1	1	0	0	0	0	0	0	0
Mobile [1]	0	0	0	0	0	1	0	0	0
Montgomery	0	0	0	0	1	0	0	0	0

[1] Typhus fever: 4 cases; 1 case at New York City, N. Y.; 1 case at Savannah, Ga.; 1 case at Miami, Fla.; and 1 case at Mobile, Ala.

City reports for week ended January 31, 1931—Continued

Division, State, and city	Meningococcus meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases estimated expectancy	Caess	Deaths
WEST SOUTH CENTRAL									
Arkansas:									
Fort Smith	1	1	0	0	0	0	0	0	0
Louisiana:									
New Orleans	6	4	0	0	1	1	0	0	0
Texas:									
Galveston	1	0	0	0	0	0	0	0	0
MOUNTAIN									
New Mexico:									
Albuquerque	0	1	0	0	0	0	0	0	0
Arizona:									
Phoenix	0	1	0	0	0	0	0	0	0
Utah:									
Salt Lake	1	0	0	0	0	0	0	0	0
PACIFIC									
California:									
San Francisco	0	0	1	0	0	0	0	3	0

The following tables give the rates per 100,000 population for 98 cities for the 5-week period ended January 31, 1931, compared with those for a like period ended February 1, 1930. The population figures used in computing the rates are estimated midyear 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 December 28, 1930, to January 31, 1931—Annual rates per 100,000 population, compared with rates for the corresponding period of 1929–30 [1]

DIPHTHERIA CASE RATES

	Week ended—									
	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
98 cities	78	113	81	115	74	108	[2] 79	110	[3] 89	112
New England	115	141	79	169	91	133	106	160	106	135
Middle Atlantic	67	81	63	107	56	89	67	91	68	98
East North Central	89	153	97	130	95	126	[4] 94	144	[5] 111	139
West North Central	82	116	98	126	82	110	84	83	111	77
South Atlantic	61	94	83	90	69	112	[6] 65	116	[6] 73	116
East South Central	70	102	116	72	70	60	76	66	70	84
West South Central	132	181	142	153	108	192	81	146	183	216
Mountain	61	53	35	70	52	53	35	35	70	35
Pacific	53	99	61	73	47	81	88	79	45	69

MEASLES CASE RATES

	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
98 cities	276	126	350	172	324	203	[2] 404	220	[3] 420	278
New England	267	129	490	121	310	172	522	230	438	341
Middle Atlantic	99	72	178	110	158	117	251	111	306	145
East North Central	54	117	63	152	87	150	[4] 74	135	[5] 144	167
West North Central	1,871	283	2,156	310	1,829	372	1,984	467	1,521	424
South Atlantic	318	144	429	128	500	182	[6] 804	172	[6] 1,062	314
East South Central	896	6	861	12	995	36	698	24	908	54
West South Central	24	91	20	293	7	373	10	582	17	293
Mountain	313	203	226	150	374	247	757	220	496	396
Pacific	24	261	33	443	55	579	72	626	110	1,028

SCARLET FEVER CASE RATES

	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
98 cities	227	242	277	266	316	272	[2] 333	288	[3] 337	292
New England	325	391	433	431	539	397	575	457	519	346
Middle Atlantic	226	175	242	220	282	212	314	226	328	239
East North Central	255	341	363	350	398	394	[4] 383	375	[5] 380	416
West North Central	235	254	296	221	321	265	323	314	386	283
South Atlantic	259	202	276	218	304	216	[6] 343	192	[6] 312	224
East South Central	291	114	396	96	465	90	483	149	512	143
West South Central	105	80	68	129	129	125	142	98	112	73
Mountain	218	388	322	493	331	344	357	379	322	414
Pacific	71	225	72	241	72	237	119	344	143	306

SMALLPOX CASE RATES

	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
98 cities	7	19	13	30	16	32	[2] 16	26	[3] 17	31
New England	0	0	0	0	0	0	0	5	0	0
Middle Atlantic	0	0	0	0	0	0	0	1	0	0
East North Central	5	16	15	27	10	36	[4] 21	19	[5] 25	39
West North Central	46	81	63	91	98	124	77	72	84	48
South Atlantic	0	2	2	0	0	6	[6] 4	2	[6] 0	6
East South Central	0	0	6	6	17	0	29	0	17	12
West South Central	17	14	37	66	27	38	34	35	51	73
Mountain	9	53	9	44	78	53	9	26	0	62
Pacific	10	89	18	146	29	123	20	152	18	152

[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 estimates as of July 1, 1931 and 1930, respectively.

[2] Springfield, Ill., and Columbia, S. C., not included.

[3] South Bend, Ind., and Columbia, S. C., not included.

[4] Springfield, Ill., not included.

[5] South Bend, Ind., not included.

[6] Columbia, S. C., not included.

Summary of weekly reports from cities December 28, 1930, to January 31, 1931—Annual rates per 100,000 population, compared with rates for the corresponding period of 1929–30—(Continued)

TYPHOID FEVER CASE RATES

	Week ended—									
	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
98 cities	5	3	4	3	5	5	[2] 6	4	[3] 5	5
New England	2	2	5	0	0	5	2	0	5	0
Middle Atlantic	4	1	2	3	2	3	3	5	2	5
East North Central	4	2	2	2	2	2	[4] 3	2	[5] 1	3
West North Central	2	0	0	2	4	12	10	2	13	4
South Atlantic	4	6	10	10	10	6	[6] 14	8	[6] 8	8
East South Central	47	6	12	6	52	12	12	18	17	6
West South Central	3	0	20	3	14	7	27	3	14	3
Mountain	17	9	17	0	9	62	17	9	0	9
Pacific	6	8	2	4	2	4	6	2	10	14

INFLUENZA DEATH RATES

	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
91 cities	16	16	24	18	36	19	[2] 52	21	[3] 70	16
New England	7	7	5	0	10	10	12	10	34	2
Middle Atlantic	17	9	29	13	59	14	91	14	101	14
East North Central	7	15	12	12	9	17	[4] 18	17	[5] 36	13
West North Central	3	27	21	30	18	17	29	18	29	18
South Atlantic	20	20	28	34	41	24	[6] 38	34	[6] 127	12
East South Central	25	26	44	58	63	39	63	52	76	52
West South Central	90	71	76	57	79	60	83	103	100	82
Mountain	17	18	44	44	35	26	44	9	52	9
Pacific	10	10	22	12	10	12	22	15	14	2

PNEUMONIA DEATH RATES

	Jan. 3, 1931	Jan. 4, 1930	Jan. 10, 1931	Jan. 11, 1930	Jan. 17, 1931	Jan. 18, 1930	Jan. 24, 1931	Jan. 25, 1930	Jan. 31, 1931	Feb. 1, 1930
91 cities	160	165	185	161	219	151	[2] 229	140	[3] 258	164
New England	159	169	113	184	159	126	178	138	185	193
Middle Atlantic	182	170	233	183	311	159	332	128	368	158
East North Central	101	114	110	121	124	108	[4] 125	110	[5] 177	128
West North Central	177	197	200	153	212	209	171	150	159	162
South Atlantic	227	240	243	192	237	186	[6] 280	214	[6] 345	238
East South Central	202	227	265	123	227	142	296	194	227	239
West South Central	186	295	238	189	228	221	245	288	203	292
Maountain	261	185	244	229	270	256	157	220	200	229
Pacific	130	92	134	120	118	137	103	77	115	92

[2] Springfield, Ill., and Columbia, S. C., not included.
[3] South Bend, Ind., and Columbia, S. C., not included.
[4] Springfield, Ill., not included.
[5] South Bend, Ind., not included.
[6] Columbia, S. C., not included.

FOREIGN AND INSULAR

CANADA

Provinces—Communicable diseases—Week ended January 31, 1931.—The Department of Pensions and National Health of Canada reports cases of certain communicable diseases for the week ended January 31, 1931, as follows:

Province	Cerebrospinal fever	Influenza	Poliomyelitis	Smallpox	Typhoid fever
Prince Edward Island [1]					
Nova Scotia		106		1	
New Brunswick [1]					
Quebec	1				11
Ontario	1	7	1	30	5
Manitoba				1	2
Saskatchewan				5	
Alberta	1				
British Columbia	3	4			
Total	6	117	1	37	18

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

Quebec Province—Communicable diseases—Week ended January 31, 1931.—The Bureau of Health of the Province of Quebec, Canada, reports cases of certain communicable diseases for the week ended January 31, 1931, as follows:

Disease	Cases	Disease	Cases
Cerebrospinal meningitis	1	Mumps	27
Chicken pox	97	Puerperal septicemia	1
Diphtheria	33	Scarlet fever	76
Erysipelas	8	Tuberculosis	52
German measles	2	Typhoid fever	11
Measles	25	Whooping cough	28

YUGOSLAVIA

Communicable diseases—December, 1930.—During the month of December, 1930, certain communicable diseases were reported in Yugoslavia as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax	40	5	Measles	1,186	14
Cerebrospinal meningitis	10	6	Puerperal septicemia	8	4
Diphtheria and croup	1,460	225	Scarlet fever	1,099	164
Dysentery	52	1	Rabies	4	4
Erysipelas	179	8	Tetanus	17	9
Glanders	1		Typhoid fever	356	58
Leprosy	1		Typhus fever	1	1
Lethargic encephalitis	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		July 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended— November, 1930: 22	November, 1930: 29	December, 1930: 6	December, 1930: 13	December, 1930: 20	December, 1930: 27	January, 1931: 3	January, 1931: 10	January, 1931: 17	January, 1931: 24	January, 1931: 31	Feb. 7, 1931
Afghanistan	C	P															
China:																	
Amoy	C		2														
	D		2														
Canton	C			1	1												
Shanghai	C		34	38	2												
	D		8	4													
Shensi Province	C		P														
Swatow	C	3	2														
Tientsin	C	2	1														
India	C	42,893	51,551	36,529	18,944	3,166	2,689	2,634									
	D	22,358	23,959	17,635	9,782	1,616	1,404	1,553									
Bassein	C		1														
Bombay	C	14	1	16	19	2	2	4	5					20			
	D	8	2	11	17	2	1	1	3					6			
Calcutta	C	63	27	24	33	4	6	2	10	9	7	6	6	36			
	D	30	12	15	16	4	4	1	7	6	4	5	5	25			
Madras	C	1		2	1					14	44	70	73				
	D	1		2						8	12	19	28	21			
Rangoon	C	1	2	1							1			1			
	D	1	1	1							1			1			
Tuticorin	C			1	1	4		1		1							
	D			1	1												
India (French):																	
Chandernagor	C		1	3	1		1										
	D			1						1							
Pondicherry	C			1	1	1	1	1	1	3	9	2		9	4		
	D			1		1	1	1	1	3	3	1		3	3		
India (Portuguese)	C	1	1		14					1							
	D		1		9												

Indo-China (see also table below):																	
Pnompenh	C	11	-	2	1	-	1	1	-	-	-	-	-	-	1	-	-
	D	6	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Saigon and Cholon	C	5	-	2	1	-	1	-	2	1	-	4	4	4	1	-	-
	D	1	-	-	-	-	1	-	-	-	-	2	2	2	1	-	-
Philippine Islands:[1]																	
Ports—																	
Cebu	C	9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iloilo	C	64	10	1	-	-	1	-	-	-	-	1	-	-	-	2	-
	D	56	14	4	-	-	3	-	-	-	-	1	-	-	-	2	-
Manila	C	1	43	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	12	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Provinces—																	
Antique	C	20	47	40	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	12	34	18	-	-	-	-	-	-	-	-	-	-	-	-	-
Bohol	C	138	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	79	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulacan	C	1	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Capiz	C	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	56
	D	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	45
Cebu	C	85	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	50	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iloilo	C	571	238	50	30	11	21	13	-	7	5	13	3	11	41	36	57
	D	376	151	40	23	8	11	8	-	6	4	10	2	9	27	25	49
Masbate	C	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Negros, Occidental	C	343	122	28	56	44	38	48	33	28	19	33	40	19	32	33	6
	D	237	91	20	41	33	17	45	28	22	16	26	33	15	17	19	5
Negros, Oriental	C	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	D	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pampanga	C	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pangasinan	C	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Samar	C	18	4	7	16	4	4	-	-	2	-	12	2	-	-	-	-
	D	16	2	7	12	4	4	-	-	1	1	7	1	-	-	-	-
Sorsogon	C	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Surigao	C	28	1	([2])	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	17	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tarlac	C	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Siam	C	3	-	4	4	2	1	1	2	2	-	2	1	-	-	-	-
	D	2	-	1	4	2	1	1	2	2	-	2	1	-	-	-	-
Bangkok	C	1	-	3	3	2	1	-	1	2	1	1	2	2	-	-	-
	D	1	-	2	2	2	1	-	1	2	1	1	1	1	-	-	-
On vessel: S. S. Malwa from Shanghai	D	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Figures for cholera in the Philippine Islands are subject to correction.
[2] During the period from Aug. 24 to Sept. 26, 1930, 26 cases of cholera with 17 deaths were reported in Manitum, Surigao Province, P. I.

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

CHOLERA—Continued

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

Place		June, 1930	July, 1930	August, 1930	September, 1930			October, 1930			November, 1930			Dec. 1-10, 1930
					1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30	
Indo-China (French) (see also table above):														
Annam [1]	C	16	1	8										
Cambodia [1]	C	144	43	59	23	13	2	16		6		1		28
Cochin-China [1]	C	273	46	27	9	6	18	14	6	8		5		8

[1] Reports incomplete.

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

PLAGUE

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

Place		July, 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended— November, 1930		December, 1930				January, 1931					Feb. 7, 1931
						22	29	6	13	20	27	3	10	17	24	31	
Algeria:																	
Algiers	C	7	11	6	11			1	1	1				1		1	
	D				3												
Constantine, vicinity of	C				1						3	1	46				
Oran	C	4	10	10	2												
	D		1	3	1												
Plague-infected rats			10	6	1												
Philippeville	C		1	3	2								1				
	D			1									1				
Argentina:																	
Cordoba Province—Chazon	C								1						1		
Jujuy Province—Palpala	C															1	
Belgian Congo	C	2	5		1				1								
	D	2	3		1				1								
British East Africa (see also table below):																	
Tanganyika	C							3		2							
	D							3		2							
Uganda	C	236	202	165	171	37	17	33	24								
	D	229	191	164	168	37	18	33	24								
Canary Islands: Las Palmas	D	1															
Ceylon: Colombo	C	2	2	3	1	1		4	4	4		4	1	1	1		
	D	2	3	3	1	1		3	4	4		4	1		1		
Plague-infected rats					1	1	1										
China:																	
Manchuria—Tungliau and Nungan	C	30	29	2													
Shensi	C		P		1												
Dutch East Indies:																	
Batavia and West Java	C	83	79	107	143	53	56	41	58	54							
	D	83	76	103	146	53	56	39	58	54							
Plague-infected rats		1	3														
Java and Madura	D	188	200	335	501	137	127	132	161	159	143						

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

PLAGUE—Continued

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

Place		July, 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended— November, 1930 22	29	December, 1930 6	13	20	27	January, 1931 3	10	17	24	31	Feb. 7, 1931
Egypt:																	
Alexandria	C	11	10	9	7		1	1	2	1	1		1				1
	D	6	8	6	7				1								
Assiout	C				3		2		7	5	1		1	2	19	2	3
	D				1				1				1	2	2	2	
Aswan	C						3										
Beni-Suef	C	1												1			
Deirout	C														19	2	
	D														2	2	
Gharbieh	C	3														1	
	D	1														1	
Girga	C		1							3	1	3					1
	D										1	1					1
Manfalut	C												23	5	21	4	
	D												5	2	3	1	
Minieh	C								1						1	1	
Port Said	C	1			2												
France: Marseille	C		5	4	4												
Gambia	C	4															
	D	4															
Greece (see also table below): Pyrgos	C			2													
India	C	877	2,497	2,371	2,721	677	746	931									
	D	477	1,132	1,068	1,497	443	434	499									
Bassein	C		2		1								2	1			
	D		3										1				
Bombay	C		1	2	1										1		
	D		1	2	1										1		
Plague-infected rats		35	47	64	30	11	5	12	4	10	4	6	13	10			
Madras Presidency	C	81	127	196	185	33	62	28	25	30	4						
	D	34	57	110	124	24	26	15	13	14							
Rangoon	C	3	10	2	2						1	1					
	D	2	9	2	1						1						
Plague-infected rats		7	8	1	1	1	1			1				2			

India (Portuguese)	D	P			3												
Indo-China (see also table below):																	
Pnompenh	C	4	3	2		1	3	1	1	1				1	3		
	D			3	1	1	3	1	1	1				1	3		
Saigon and Cholon	C	1	1	1													
Iraq: Baghdad	C	9		1	P	2	2									3	
	D	3		1		1	1									2	
Kwang-Chow-Wan	C	1															
Madagascar (see also table below): Tamatave	C	2	1	1	5		2	1	1		2						
	D			1	3		2		1								
Morocco	C	15			5					9		10		13			
	D	2								4		4		4			
Nigeria: Lagos	C	7	6	5	38	4	3	2		2	1	1	1				
	D	7	6	5	5	4	3	2		2	1	1	1				
Plague-infected rats		8	10	11	13	1	1	1	2	4		1					
Peru: Lima.[1]																	
Senegal (see table below).																	
Siam	C	7	3	1	6												
	D	6	2		5												
Bangkok	C	3			1				1		1	2					
	D	2			1				1		1	2					
Nagara Rajsima	C	2	1	1	1		3		8	4	3	4	6	3			
	D	2	1	1	1		3		6	3	3	1	3	2			
Syria: Beirut	C	2	5		6								1				1
Tripolitania	C	2			1	4	6	2	1					2	2		
	D					1								2			
Tunisia:																	
Sfax district	C	1															
Tunis	C				1				P	12			1	1			
Union of Socialist Soviet Republics:																	
Salsk region	C	7															
	D	5															
Transcaucasia-Karabakh	C														6		
Union of South Africa:																	
Cape Province	C	1	1		1		P	P									
	D	1	1														
Orange Free State	C		2														
	D		2														
On vessel: S. S. Marionga de Thermiotis at Avonmouth	C									1							

[1] Eight cases of plague were reported at Lima, Peru, during December, 1930. Plague infection is said to exist in interior towns north of Lima.

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

PLAGUE—Continued

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

Place		July, 1930	Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930
British East Africa (see also table above):							
Kenya	C	97	87	53	58	62	50
Greece (see also table above)	C	-------	-------	-------	2	-------	-------
Indo-China (see also table above)	C	1	2	4	-------	-------	-------
Madagascar (see also table above):							
Ambositra Province	C	-------	-------	-------	4	16	-------
	D	-------	-------	-------	4	16	-------
Antsirabe Province	C	24	11	21	3	10	-------
	D	24	11	21	3	10	-------
Miarinarivo Province	C	1	2	7	18	8	-------
	D	1	2	7	18	8	-------
Moramanga Province	C	-------	27	18	20	8	-------
	D	-------	27	17	20	8	-------
Tananarive Province	C	28	39	79	125	-------	-------
	D	28	38	79	116	-------	-------
Senegal:							
Baol [1]	C	62	79	48	53	-------	-------
	D	48	20	23	35	4	-------
Dakar [1]	C	140	108	3	-------	-------	-------
	D	122	90	8	-------	-------	-------
Louga [1]	C	138	75	61	37	10	-------
	D	103	33	30	25	3	-------
Thies [1]	C	54	34	12	24	27	2
	D	30	20	4	15	23	1
Tivaouane [1]	C	119	110	20	53	31	2
	D	70	54	14	31	25	1

[1] Reports incomplete.

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

SMALLPOX

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

Place		July 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended November, 1930		December, 1930				January, 1931					Feb. 7, 1931
						22	29	6	13	20	27	3	10	17	24	31	
Algeria:																	
Algiers	C	3								1							
Bone	C															1	
Constantine	C				1												
Oran	C								3								
Brazil:																	
Porto Alegre (alastrim)	C	1	1	26	36	20	8										
Rio de Janeiro	C				2												
British East Africa (see also table below): Tanganyika	C	242	522	95	17	7	26	18	334	23	1	57					
	D	37	60	6	1		1		35	1		3					
British South Africa: Southern Rhodesia	C	1	1	153	95	12		4									
	D					2		1									
Canada:																	
Alberta	C	1	1	22		1						19			7		
British Columbia—Vancouver	C	6	2	2	3			1				1	2				
Manitoba	C		1														
Winnipeg	C												1				
Ontario	C	20	10	19	59	7	12	3	1	1		8	8	10	3		
Kingston	C										2	4		1			
North Bay	C										1		1				
Ottawa	C	7	5		37		8	1	1			2		1	1	1	
Sault Ste. Marie	C												1	11	8	5	6
Toronto	C		1				2	2									
Quebec	C	5				1			1						2		
Montreal	C	7															
Saskatchewan	C	8	1	3	2	2		16						7	6		

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

SMALLPOX—Continued

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

Place		July 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended: November, 1930: 22	29	December, 1930: 6	13	20	27	January, 1931: 3	10	17	24	31	Feb. 7, 1931
China:																	
Changking	C	P	P	P	P	P		P	P	2							
Foochow	C	P	P	P	P		P		P								
Hong Kong	C										1						
Manchuria—																	
Harbin	C	2			1												
Kwantung—Dairen	C					2		1	1	1							
	D								1								
Nanking	C	P	P	P	P			P	P	P	P	P					
Shanghai—																	
Foreigners only	C	3	18	1	2			3	5	4	2	6	2	1	1		
Including natives	D		2		1				4	5	1	1	4	2	4		
Swatow	D	4	2	4	3	1			2		2	1	2				
Tientsin	C			1	1	1	1										
Chosen (see table below).																	
Colombia:																	
Barranquilla	C	2															
Buenaventura	C	2															
Cali	D			2				1									
Curacao (alastrim)	C	1															
Dutch East Indies:																	
Java—Batavia and West Java	C	12	11	14	26	2		2	2	2		2					
	D	5	4	4	4	1			1			1					
Sanggi Islands	C	36	14		29												
	D	2	3		3												
France (see table below).																	
Greece (see table below).																	
Great Britain:																	
England and Wales	C	344	341	325	372	116	160	95	137	138	135	164	228	187			
Bradford	C		3	1	1			1				1					
Cardiff	C			1													
Leeds	C			1	2							2					
London	C	164	120	29	172	67	27	48	42	27	38	48	48	45			

London and Great Towns	C	268	223	52	296	136	74	112	111	105	131	162	162	154			
	D		1		1		1										
Stoke-on-Trent	C	2	1		1												
Scotland	C	5															
Honduras:																	
Naco	C		5														
Puerto Castilla	C																
India	C	4,877	3,131	2,322	2,412	787	865	1,037					4	7	1		
	D	1,246	680	572	606	221	174	274									
Bombay	C	12	6	1				1				1	1	2			
	D	10	5					1				1	1				
Calcutta	C	25	14	12	9	3	5	6	4	10	19	15	15	28			
	D	21	9	11	7	3	2	4	2	7	13	10	10	16			
Cochin	C	14	3	12	25	4	5	6	7	6	7	2	5				
	D		1	1	3	2		2					1				
Karachi	C	4	4			2	1										
	D	3	2				1										
Madras	C	38	34	19	9	3	5	6	6		1	3	4				
	D	11	6	8	2			2	1			1					
Moulmein	C	2	1														
	D	1	1														
Negapatam	C	4	9	14	9	3		1	2								
Rangoon	C	3		2	1		1										
	D				1												
Tuticorin	C			1													
Vizagapatam	C			1													
India (French):																	
Chandernagor	C		3	3	3						5						
	D		2	1	1						2	1		1			
Karikal	C	9	5	1								1	2	1			
	D	9	2	1									2				
Pondicherry Province	C	22	35	38	11	7	7		5	8	8	7					
	D	22	33	36	11	7	5		5	7	8	7					
India (Portuguese)	C	9	4							1							
	D	2															
Indo-China (see also table below):																	
Pnompenh	C			2			1				2						
	D	1					1										
Saigon and Cholon	C	1	1		2	2	1		1					3	1		
	D	3	1		2	1			1					2			
Iraq:																	
Baghdad	C	1	1	2													
	D	1															
Mosul Liwa	C			69	6	7	9						1		2		
	D			27		1	1										
Ivory Coast (see table below).																	
Mexico (see also table below):																	
Jalisco (State) Guadalajara	D	1		3	3	1		2							1		
Juarez	C	2															
	D	1		1	1												
Mexico City and surrounding territory	C	10	12	13	9	1	2		3	1	5						
	D	6	5	3	2				6	2	1						
Vera Cruz	C				1												

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

SMALLPOX—Continued

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

Place		July 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Oct. 19–Nov. 15, 1930	Week ended: November, 1930		December, 1930				January, 1931					Feb. 7, 1931
						22	29	6	13	20	27	3	10	17	24	31	
Morocco (see table below).																	
Nicaragua: Porto Cabezas	C									2							
Poland	C				8	1	2						2				
Portugal:																	
Lisbon	C	50	27	16	20	11		15	11	21	17		34	27			
Oporto	C	1															
Siam	C			1													
Somaliland, British: Boales	C			1	1			1					1				
	D			1													
Spain	C	2	5		51	23	21	23		19	31	18					
Straits Settlements	C	8	6	5	10	3	9	2	3	3		1	3				
	D	3	1	1	2	1	2		2	2							
Sudan (Anglo-Egyptian)	C	42	128	82	5		3		47		47		17	1	7		3
	D	3	52	7	1				5		5		1		7		
Sudan (French) (see table below).																	
Switzerland: Berne Canton	C	2		1													
Syria (see table below).																	
Tunisia: Tunis	C			2								13	4	6			
Turkey (see table below).																	
Union of South Africa:																	
Cape Province	C		P	P	P	P		P	P	P	P						
Orange Free State	C	P			2	P	P	P									
Transvaal	C	P	P	P	P	P	P	P	P	P	P						
Upper Volta	C						6						4				
On vessel:																	
S. S. Muncaster Castle at Manila from Hong Kong	C										1						
S. S. Matheran at Suez from Calcutta	C														1		

Place		June, 1930	July, 1930	August, 1930	September, 1930	October, 1930			November, 1930			December, 1930		
						1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31
Indo-China (see also table above)	C	213	238	93	192	32	62	164		86		38	9	14
Ivory Coast	C							4		2		9		
Sudan (French)	C	76	34	39	P		17					43		96
	D	18		3			2					16		4
Syria: Beirut	C	7	2	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	3	2				
Seishin	C	2					
France	C	1					

Place		July, 1930	Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930	Dec., 1930
Greece	C	1	6				
Mexico: Durango (see also table above)	D	3	3	2			1
Morocco	C	3	8	4	4	20	
Turkey	C	51	21	19	74		
	D	13	4	2	1		

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

TYPHUS FEVER

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

Place		July 27–Aug. 23, 1930	Aug. 24–Sept. 20, 1930	Sept. 21–Oct. 18, 1930	Week ended— Oct. 25, 1930	November, 1930: 1	8	15	22	29	December, 1930: 6	13	20	27	January, 1931: 3	10	17	24
Algeria:																		
Algiers	C	2	3				1			2								
Constantine Department	C	3		2	1					1		1			3	3		
Oran	C	1	1	3						3		2						
Bulgaria	C	1	4	6			1	2	1	1	3	6	3				9	
	D												1					
China:																		
Manchuria—Harbin (see also table below)	C	2	2	1							1							
Shanghai	C	1																
Chosen (see table below).																		
Czechoslovakia (see table below).																		
Egypt:																		
Alexandria	C	1	3	1				2	1	1								
	D		1					2										
Beheira Province	C		1										1					
	D												1					
Cairo	C	7	2									1	1					
Port Said	C	4	1	1	1	1												1
Ireland:																		
Irish Free State—																		
Mayo County—																		
Castlebar	C	1																
Westport	C	1																
Latvia (see table below).																		
Lithuania (see table below).																		
Mexico:																		
Durango	D		1	2														
Mexico City, including municipalities in Federal District	C	9	7	8	1	1	5	4	1	1		12	5	2				
	D	2	2	2	1		3		2	3		2	4	1				
San Luis Potosi	D										1	1						
Morocco	C	8	2		1		1	1	1				8					
	D			1														
Palestine	C	3	3	3			2	1	1	6			1	1		2		1

Poland	C	34	23	22	7	8	15	7	12		21	9	18	5	28	11		
	D	3	1	2					1		3	3	3					
Portugal: Oporto	C	1		2		2	1	1	2	2	2							1
Rumania	C	9	4	14	4	13	10	14	19		15							
	D	2					1	1	1		2							
Spain	C		1	2			4				1							
	D		1	2							1							
Tunisia	C	10	6	12					5		23							
Turkey (see table below).																		
Union of South Africa:																		
Cape Province	C	P	P	P	P	P	P	P	P	P	P	P	P	P				
Municipality of East London	C		2	1				1	1				P		2			
Natal	C	P	P	2	P	P	P											
Orange Free State	C	P	P										P	P				
Transvaal	C	P	P	P	P	P	P	P	P	P			P	P				
Yugoslavia (see table below).																		

Place		June, 1930	July, 1930	Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930
China: Harbin (see also table above)	C		14	5		3	
Chosen: Seoul	C	2	3	2	1	7	1
Czechoslovakia	C	1		1			16
Greece: Athens	C	3	6	6	4	4	4
Latvia	C	3	3	1	2		

Place		June, 1930	July, 1930	Aug., 1930	Sept., 1930	Oct., 1930	Nov., 1930
Lithuania	C	16	18	7	24	1	5
	D			1	2		1
Turkey	C	2	7	11		28	3
Yugoslavia	C	6		2		2	2
	D			1		1	

YELLOW FEVER

	Cases
Brazil:	
Campos, Rio de Janeiro Province, May 23, 1930	1
Para—	
June 23, 1930	2
July 29, 1930 (death)	1
Gold Coast:	
July 10, 1930	1
Albosso, Aug. 4, 1930 (death)	1
Liberia, Monrovia, June 3, 1930	1
Nigeria, Lagos, July 12, 1930 (probably laboratory infection)	1

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