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THE EFFECT OF HEMOLYTIC STREPTOCOCCI AND THEIR PRODUCTS ON LEUCOCYTES

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Knowledge of the nature of the injury done to the tissues and wandering cells of the host by invading organisms and their products is fundamental to progress in the treatment of infectious diseases. The injury that may be done by hemolytic streptococci to the leucocytes, which are much concerned in the combat between host and invading bacteria, is the subject of the investigation here reported.

REVIEW OF LITERATURE

In the literature on infectious diseases there are many references to a decline in phagocytic activity against the specific infecting organism in fatal cases. In most of the investigations no inquiry was made to determine which of the two chief factors involved was at fault—antibody content or leucocytic efficiency; and those who have ascribed a decrease of phagocytic activity to injury of the leucocytes have generally not determined what factor in the bacterial product was responsible for the injury.

Cross found no decrease in phagocytic activity against any bacteria not concerned in the primary infection, even in the late stages of fatal disease. His results, suggesting that the nonspecific factor, the leucocytic efficiency, is not at fault in fatal cases, are at variance with the results of other investigators who have shown that streptococci and staphylococci disintegrate leucocytes.

As long ago as 1894 Van de Velde found a substance capable of disintegrating leucocytes in the exudate obtained by injecting staphylococci into the pleural cavity of rabbits. He found that this substance was destroyed at about 58° C. From this fact he concluded that it was albuminous. He gave it the name "leucocidin." He was able to demonstrate the action of leucocidin in test tube experiments as well as *in vivo*. Later Neisser and Wechsberg studied the staphylococcal leucocidin and concluded it was not the same as hemolysin, because the two toxic substances did not appear and disappear under the same conditions.

The following review of the literature on the production of substances harmful to leucocytes by streptococci reveals uncertainty and misunderstanding. No definite facts comparable to the facts known about staphylococcal leucocidin are established.

M'Leod (1915) reported that, in streptococcal septicemia accompanied by marked hemolysis, the protoplasm of the leucocytes is completely disintegrated. He was unable, however, to show the action of the leucocidic substance *in vitro* with filtrates of streptococcus cultures. Many years later he returned to the problem, and reported (Channon and M'Leod, 1929) that, if the filtrate from a young streptococcus culture were concentrated to one-fourth of its original volume, a toxic substance capable of disintegrating leucocytes could be demonstrated in the concentrate.

Channon and M'Leod call attention to the fact that no evidence has been obtained to show that the cytolytic effects of streptococci on red cells and leucocytes are due to different toxic substances.

Levaditi (1918) reported that he found incontestable proof that streptococci as well as staphylococci possess the power of destroying white cells *in vitro*. He was unable, however, to demonstrate leucocidic substance in filtrates of young or old cultures, or in extracts of dead microbes, or in macerated living streptococci. He concluded, therefore, thats treptococcal leucocidic substance is connected with the vitality of the microbes and is active only when they come in contact with leucocytes.

Nakayama (1920) believed that he could demonstrate a leucocidic substance in streptococcus culture filtrates. He used two tests for the vitality of the leucocytes: (1) The observation of ameboid movements; (2) the bioscopic tests devised by Neisser and Wechsberg to demonstrate staphylococcal leucocidin. In this test the capacity of the leucocytes for the reduction of methylene blue is taken as a measure of their vitality. Nakayama's results are confused by the use of glucose in the culture medium. It will be pointed out further on that acids are toxic for leucocytes. Hence carbohydrates, from which streptococci produce acids, should be excluded from experiments planned to demonstrate a toxic substance of the nature of that described by Van de Velde.

Using the bioscopic test of Neisser and Wechsberg for testing the vitality of cells, Dold (1930) reported that the streptococcal toxins in culture filtrates destroy not only leucocytes but also other tissue cells. Not all strains of hemolytic streptococci were found to produce the toxic substance, however, and a given strain sometimes would, and at other times would not, show evidence of its production.

Among the later writers on the subject, Wright and his collaborators (Wright, Colebrook, and Storer; Colebrook; and Hare) have reported experiments in which the phagocytic capacity of leucocytes from patients' blood was tested. They found that in septic infections the efficiency of the leucocytes is definitely subnormal when tested in normal serum, and that this efficiency appears to be reduced for all microbes indiscriminately.

No data could be found in the literature which would show whether or not the streptococcal toxin capable of producing a characteristic skin reaction (referred to hereafter in this paper as skin toxin) is toxic for leucocytes. Because many investigators have reported that there is no relationship between toxin production and virulence, it is generally inferred that the skin toxin does not affect leucocytes. That not all investigators accept that point of view, however, is illustrated by the following excerpt from Downie's recent paper: "From a histological study of the lesions it would appear that toxin acts by preventing phagocytosis so that the organisms can establish themselves and produce sufficient toxin to cause death of the animal. * * * The marked leucocytic accumulation at the site of intradermal injection in the toxin-immunized, as compared with the absence of such reaction in the coccus-immunized rabbits, is further evidence of the antiphagocytic action of toxin."

In 1922 the writer reported the sensitiveness of leucocytes to acids. Hydrochloric acid was found to be toxic in weak dilutions. Lactic acid caused more injury than hydrochloric, and acetic and butyric more than lactic, when all the acids were of the same H ion concentration. The effect of the acids on the leucocytes was cumulative. If the leucocytes were washed several times with an acid solution too weak to cause injury by a single washing, they absorbed the acid from the solution in each washing until finally enough had been absorbed to incapacitate them for phagocytosis.

Since many pathogenic bacteria, including streptococci, are vigorous producers of acids, and since the acids have been shown to be injurious to leucocytes, they must be considered as one of the possible agents which may incapacitate the leucocytes during the progress of a disease caused by acid-producing bacteria.

All the literature on streptococci that has been reviewed may be summed up as follows:

1. Streptococci destroy the phagocytic capacity of leucocytes.
2. No data were found which would show the effect of the skin toxin on leucocytes.
3. Although streptococci produce acids which have been shown to be toxic for leucocytes, acids have not been considered as one of the toxic substances which may incapacitate leucocytes *in vivo;* and some investigators have complicated their experiments planned to show a thermolabile leucocidic substance by failing to eliminate acids from their medium.
4. Whether or not streptococcal leucocidic substance is identical with hemolysin remains an open question.

EXPERIMENTAL WORK

In this study three methods were used to demonstrate the injurious effects of streptococci and their products on leucocytes: (1) The capacity of the treated leucocytes to ingest sensitized bacteria was determined by a modified Neufeld's technique; (2) disintegration of the treated leucocytes was observed in microscopic preparations; (3) the vitality of the treated leucocytes was determined by testing their capacity for the reduction of methylene blue (the bioscopic test of Neisser and Wechsberg).

THE PHAGOCYTIC TEST

A modified Neufeld's technique, the same as that used in the earlier study on the toxic effect of acids on leucocytes, was employed.

The fluid for the dilution of serum, for the dilution of test substances, and for the suspension of leucocytes in control tests was prepared by the addition of 1 part of Sorensen's phosphate buffer mixture adjusted to pH 7.0 to 9 parts of a 0.9 per cent sodium chloride solution. (It was found in the earlier study that a buffered solution was necessary for the protection of the leucocytes against chance contact with unfavorably acid solutions.)

H ion determinations were made with the use of standard buffer solutions and dye indicators.

A strain of hemolytic streptococcus originally cultivated from a case of erysipelas was used as "food" for the leucocytes and for the preparation of an immune serum for its sensitization. The serum was prepared by injecting a rabbit repeatedly with increasing doses of an antigen killed with formalin and thoroughly washed. It was preserved with 0.2 per cent tricresol. It had been kept in a refrigerator for about five months when these tests were made. It had a bacteriotropin[1] titer of approximately 1:1280. The experiments were all carried out in triplicate, in low dilutions of the serum, as indicated in the protocols.

Two-tenths of a cubic centimeter of diluted serum and an equal quantity of a 24-hour broth culture of the streptococcus were placed together in 1 by 7 centimeter reagent tubes and incubated in a 37° C. water bath for 45 minutes. During the incubation the leucocyte suspensions were prepared.

Rabbit leucocytes were used. They were obtained by injecting into each pleural cavity about 5 cubic centimeters of sterile aleuronat[2] suspension on the day preceding the test.

All solutions in which the leucocytes were to be suspended were warmed to 37° C. The exudate was taken up in a solution of 1 per

[1] The bacteriotropins are called "stable opsonins" by some writers.

[2] The alcuronat suspension was made by adding 3 per cent starch and 5 per cent aleuronat to ordinary broth.

cent sodium citrate in physiological saline solution. About 50 cubic centimeters of the citrate solution was used for washing each pleural cavity. If the exudate was very bloody, the first fractions of the bloody washings were discarded and the later fractions were usually found to be sufficiently free from red blood corpuscles to be used in the test. Usually small particles of aleuronat or small clots of fibrin or blood were washed out with the exudate. They sank to the bottom of the container and were disposed of by decanting the supernatant suspension into a fresh container, mixing the leucocytes from the two pleural cavities.

A 12-cubic centimeter portion of the leucocyte suspension was placed in each of as many centrifuge tubes as there were substances to be tested. The suspensions were centrifugated for four minutes at such a speed that the majority of leucocytes were thrown to the bottom of the tube, leaving a slightly clouded supernatant fluid (the cloudiness indicating that the leucocytes had not been subjected to a compression great enough to injure them). The supernatant fluid was poured away and the sediment was emulsified in 12 cubic centimeters of buffered saline solution or test material according to the plan of the experiment. (In the protocols this is called the "second washing.") The suspension was centrifugated again in the same manner as before. This sediment was carefully emulsified in 1.5 cubic centimeters of the test or control solution and the leucocytes were then ready for the test.

Two-tenths of a cubic centimeter of leucocyte suspension was added to each tube of sensitized bacteria. The tubes were shaken to obtain a uniform suspension, and then were returned to the water bath for further incubation. During this second incubation period the racks containing the tubes were kept in vigorous motion by an electric shaking apparatus, in order to prevent the leucocytes from sinking to the bottom of the tubes. After 45 minutes' incubation, the tubes were removed from the water bath and smears were made. Before making a smear, a uniform suspension was obtained by vigorously rolling the tube between the hands. After drying, the smears were fixed with methyl alcohol. After drying again, they were stained by submerging the slides for a few minutes in a weak solution of Bordet-Gengou's toluidine blue.[3]

Phagocytosis by the polymorphonuclear leucocytes alone was considered in this study. A characteristic picture of the phagocytosis of bacteria which have been sensitized with immune serum shows a large percentage of those leucocytes which participate in phagocytosis crowded full of bacteria. For this reason it was impossible to

[3] Bordet-Gengou's toluidine blue is made by dissolving 5 grams of toluidine blue in 100 cubic centimeters of alcohol, 500 cubic centimeters of water, and 500 cubic centimeters of 5 per cent phenol, and filtering after one or two hours. One part of stain was diluted with two parts of water for staining the smears.

count the number of cocci ingested as is commonly done in the opsonic test. Twenty-five polymorphonuclear leucocytes in each smear were examined, and the presence of bacteria was recorded in terms of percentage. It was observed that those leucocytes that were agglutinated generally contained more bacteria than the isolated leucocytes. Therefore, if there had been a clumping of the leucocytes, about one-half of the number counted was chosen from one or more groups and the remainder were counted from the isolated leucocytes. Record was kept of the percentage of phagocyting leucocytes, and also of the percentage of leucocytes containing more than 10 cocci. They were tabulated in terms of leucocytes "filled" with bacteria.

Description of the toxins.—The streptococcal skin toxin used in these experiments was prepared by Surg. M. V. Veldee, of the National Institute of Health, for his own experimental work. The strain used for the preparation of the toxin was the well-known "N. Y. 5," originally cultivated by Doctor Dochez from a case of scarlet fever. The organism was grown for 89 hours at 37° C., in Douglas tryptic digest medium, as described by Watson and Wallace. The filtered toxin was of an H ion concentration of pH 7.6. It had a toxin content of approximately 60,000 skin test doses per cubic centimeter.

Diphtherial and tetanus toxins were included in some of the tests to compare their action on leucocytes with that of the streptococcal toxin. The diphtherial toxin was a sample which had been sent to the National Institute of Health by a commercial firm. It contained approximately 500 M. L. D. per cubic centimeter for guinea pigs weighing 250 grams. The National Institute of Health standard tetanus toxin was used, diluted in buffered saline solution as indicated in the respective protocols.

The effect of streptococcal skin toxin on the phagocytic capacity of leucocytes.—The phagocytic experiments were planned so that the activity of the leucocytes exposed to streptococcal skin toxin could be compared with the activity of those exposed to several inert substances, in order to demonstrate the uniformity of the phagocytic activity of healthy leucocytes. Tetanus and diphtherial toxins served as inert substances. (Many years ago Bordet showed that diphtherial toxin does not affect leucocytes.) To demonstrate the sensitiveness of leucocytes to harmful substances, parallel tests were made with solutions of acetic acid and phenol. Acetic acid was chosen because it is one of the acids produced in the fermentation of carbohydrates by streptococci. (Langwill.)

The conditions for the parallel phagocytic tests on any given date were the same except for the one variable condition of the exposure of the leucocytes to the various test or control substances. Hence

the given figures in any one protocol are comparable, but they are not comparable with the figures given in other protocols, because conditions such as abnormal temperatures to which the leucocytes might be subjected during the course of preparation of the suspension, the phagocytic efficiency of the leucocytes of the different individual rabbits, and other conditions might vary from day to day. Thus the figures for the uninjured leucocytes are markedly lower in the protocols shown in Tables 2 and 4 than in those shown in Tables 1 and 3. The conclusions to be drawn from the several protocols, however, are in agreement.

It was a surprise to find that in 0.1 or 0.2 per cent solutions of phenol there was no inhibition of phagocytosis (see Table 1). It had previously been shown that phagocytosis was completely inhibited by 0.5 per cent solution. The limit of toleration for phenol was, therefore, determined. It was found that, although a 0.2 per cent solution does not affect the activity of the leucocytes, it is completely inhibited in a 0.4 per cent solution (see Table 2), and there is only slight activity in a 0.3 per cent solution (see Table 3).

The results of all the experiments agreed in showing that under the specified conditions streptococcal skin toxin has no effect on the phagocytic activity of leucocytes (see Tables 1, 2, and 3).

Recovery of leucocytes after injury due to acid.—The sensitiveness of leucocytes to acetic acid is demonstrated in Tables 2, 3, and 4. The results showing inhibition of phagocytosis by acetic acid agreed with those reported in the earlier publication.

TABLE 1.—*Protocol of experiment showing that, under the conditions of the phagocytic test, streptococcal skin toxin, tetanus toxin, and 0.1 per cent phenol do not injure the leucocytes. (Second washing of leucocytes was in buffered saline solution; final suspension was a solution of the test or control material)*

No. of the test	Control or test material	pH of the solutions of the control or test material	Dilution of immune serum used for sensitization of streptococci			Streptococci not sensitized but suspended in control solutions	
			1:20	1:40	1:80	Buffered saline solution	Normal serum diluted 1:20
1	Buffered saline solution	7.0	[1] 68	56	76	12	4
			[2] 48	28	36	0	0
2	Streptococcal toxin	7.6	76	64	60	16	4
			56	44	40	0	0
3	Tetanus toxin [3]	6.4	56	64	72	8	4
			40	56	64	0	0
4	0.1 per cent phenol	7.0	64	76	48	12	0
			56	40	20	0	

[1] The upper figure refers to the percentage of phagocyting leucocytes.
[2] The lower figure refers to the percentage of leucocytes containing 10 or more cocci.
[3] The tetanus toxin was diluted to contain approximately 4,800 M. L. D. per cubic centimeter for 350-gram guinea pigs.

TABLE 2.—*Protocol of experiment showing that, under the conditions of the phagocytic test, streptococcal skin toxin, tetanus toxin, and diphtherial toxin do not, while acetic acid and 0.4 per cent phenol do, injure the leucocytes. (Second washing and final suspension of the leucocytes were in solutions of the test or control material)*

No. of the test	Control or test material	pH of the solutions of the control or test material	Dilution of immune serum used for sensitization of streptococci			Streptococci not sensitized but suspended in control solutions	
			1:20	1:40	1:80	Buffered saline solution	Normal serum diluted 1:20
1	Buffered saline solution	7.0	[1] 44	48	40	16	8
			[2] 20	16	20	4	0
2	Streptococcal toxin	7.6	44	36	36	12	8
			16	16	16	4	0
3	Tetanus toxin [3]	6.4	32	52	32	16	8
			20	16	20	4	0
4	Diphtherial toxin	7.6	48	40	32	8	16
			16	12	12	4	0
5	Acetic acid	4.8	16	28	16	0	0
			0	4	12		
6	0.2 per cent phenol	7.0	64	56	40	16	8
			28	28	28	4	0
7	0.4 per cent phenol	7.0	12	8	4	0	0
			4	0	0		

[1] [2] See Table 1 for significance of the figures.

[3] The tetanus toxin was diluted to contain approximately 3,600 M. L. D. per cubic centimeter for 350-gram guinea pigs.

TABLE 3.—*Protocol of experiment showing that, under the conditions of the phagocytic test, streptococcal skin toxin and diphtherial toxin do not, while acetic acid and 0.3 per cent phenol do, injure the leucocytes. (Second washing and final suspension of the leucocytes were in solutions of the control or test material)*

No. of the test	Control or test material	pH of the solutions of the control or test material	Dilution of immune serum used for sensitization of streptococci			Streptococci not sensitized but suspended in control solutions	
			1:20	1:40	1:80	Buffered saline solution	Normal serum diluted 1:20
1	Buffered saline solution	7.0	[1] 60	68	40	16	0
			40	44	28	4	
2	Streptococcal toxin	7.6	64	48	48	12	8
			28	36	32	8	0
3	Diphtherial toxin	6.4	64	52	48	4	12
			32	24	12	0	0
4	Acetic acid	4.8	28	24	32	8	8
			8	12	8	4	0
5	0.3 per cent phenol	7.0	20	24	32	0	4
			0	4	4		0

[1] See Table 1 for the significance of the figures.

A few experiments were carried out to determine whether leucocytes readily recover from the injury caused by acetic acid. The protocol of a typical experiment is given in Table 4. The technique used for the phagocytic experiments previously described in this paper was modified for these tests. Leucocytes slightly injured so that phagocytic

activity was only partially destroyed and leucocytes which had been exposed to amounts of acid very slightly exceeding their limit of toleration were used. Under the conditions of these experiments leucocytes washed in acetic acid of an H ion concentration of pH 4.8 showed partial destruction of phagocytic activity, and those washed in acetic acid of an H ion concentration of pH 4.6 showed almost or quite complete destruction of phagocytic activity. These and slightly greater concentrations of acid, were used in the experiments.

The leucocyte suspension in sodium citrate solution as obtained from the pleural cavities of a rabbit was divided into eight portions and centrifugated, and the supernatant fluid was poured away. The tubes were then divided into two series, A and B, of four tubes each. The leucocytes in the tubes of the series designated A were tested for phagocytic activity immediately after washing in the various control and test solutions, and those in the corresponding tubes of the B series which had been exposed to the same solutions as those of the A series were suspended in several cubic centimeters of fresh serum from a normal rabbit and incubated in a water bath at 37° C. for an hour or two and then tested for phagocytic activity. The treatment of the leucocytes in the various tubes after the first centrifugation and disposal of the sodium citrate solution was as follows:

Series A. Tube 1 (control)—(*a*) The leucocytes were washed in 12 cubic centimeters of buffered saline solution and centrifugated. (*b*) They were resuspended in 1.5 cubic centimeters of the buffered saline solution and added to the sensitized bacteria to test for phagocytic capacity.

Tube 2.—The leucocytes were treated like those in Tube 1 except that the washing and final suspension was in acetic acid of pH 4.8.

Tube 3.—The leucocytes were treated like those in Tube 1 except that the washing and final suspension was in acetic acid of pH 4.6.

Tube 4.—The leucocytes were treated like those in Tube 1 except that the washing and final suspension was in acetic acid of pH 4.4.

Series B. The four tubes of Series B were treated like the corresponding tubes of Series A through (*a*) and (*b*). (*c*) The suspensions were centrifugated and the leucocytes were resuspended in a few cubic centimeters of fresh rabbit serum and incubated for an hour or two in a water bath at 37° C. (*d*) The suspensions were centrifugated again and the supernatant serum was poured away. (*e*) The leucocytes were resuspended in 1.5 cubic centimeters of buffered saline solution, and this suspension was added to sensitized bacteria to test the phagocytic capacity of the leucocytes. All the tests were carried out in triplicate, with the same strain of streptococcus sensitized with the same increasing dilutions, all low, of the same high titered homologous serum used in the experiments recorded in Tables 1, 2, and 3.

Table 4 shows that leucocytes whose phagocytic capacity had been slightly injured by washing in acetic acid of pH 4.8 were restored to their usual activity (as compared with leucocytes washed in buffered saline solution) by incubation in fresh serum. Leucocytes whose phagocytic activity had been almost completely inhibited by washing in acetic acid of pH 4.6 were also restored to their usual activity by incubation in fresh serum. On the other hand, the leucocytes which had been washed in acetic acid of pH 4.4 were so badly injured that incubation in fresh serum had no effect on them. The experiment was repeated several times with similar results.

TABLE 4.—*Protocol of experiment showing the effect of incubation in normal serum on leucocytes which have been injured by acetic acid*

[The triplicate sets of figures show leucocytic activity for bacteria sensitized with three different low dilutions of homologous immune serum]

No. of the tube containing the leucocyte suspension	Treatment of the leucocytes	Series A (Activity of leucocytes was tested immediately after washing in the control or test solutions)			Series B (Activity of leucocytes was tested after washing in control or test solutions and then incu bating for an hour infresh serum)		
1	(Control) washed in buffered saline solution pH 7.0.	[1] 32	40	36	40	32	28
		[2] 12	20	20	20	16	16
2	Washed in acetic acid, pH 4.8	16	20	16	28	28	44
		12	12	4	20	16	20
3	Washed in acetic acid pH 4.6	12	4	4	32	20	32
		4	0	0	20	16	20
4	Washed in acetic acid pH 4.4	4	0	4	4	0	4
		0		0	0		0

[1] [2] See Table 1 for the significance of the figures.

It would be impossible to duplicate in a test tube experiment the injury done to leucocytes by the acids produced by the bacteria in a focus of infection. The body fluids are sufficiently buffered so that the circulating blood never reaches an H ion concentration low enough to affect the leucocytes. But due to their strong affinity for acids it appears possible that the leucocytes accumulated at the site of infection may gradually take up the acids until their limit of toleration is reached and phagocytic capacity is finally crippled. There would be a continuous absorption of dilute acids, and at the same time there would be a more or less continuous restoration to a healthy condition, dependent on the flow of blood through the focus of infection. The results of the experiments suggest that leucocytes slightly injured by acid may be restored to their usual activity if there is a good circulation of blood in the focus of infection; whereas if the blood supply is deficient, the leucocytes may become injured beyond recovery.

THE DISINTEGRATION OF LEUCOCYTES BY STREPTOCOCCI [4]

An attempt was made to demonstrate the disintegration of washed leucocytes in the presence of washed streptococci by changes in the H ion concentration of the saline solution in which they were suspended. A slight increase of H ions was sometimes indicated but this method of detecting the disintegration of leucocytes was abandoned because there were too many complicating factors, chief among which was the increase of H ions, due to the autolysis of the leucocytes.

When washed leucocytes and washed streptococci were suspended together in physiological saline solution, the disintegration of the leucocytes could be observed in microscopic preparations. The technique described for the phagocytic test was used for obtaining and washing the leucocytes and for the preparation of slides for microscopic examination. It was necessary to wash the streptococci rapidly because their capacity for attacking the leucocytes was quickly injured by saline solution. The culture was centrifugated, the supernatant fluid was removed, and a few cubic centimeters of saline solution were allowed to flow gently over the sediment without disturbing it. The wash fluid was removed and the sediment was emulsified in a small quantity of saline solution, making a heavy suspension, which was immediately added to a suspension of washed leucocytes. Under these conditions there was practically no phagocytosis. Smears prepared after 2, 3, or 4 hours' incubation showed definite disintegration of leucocytes, as compared with control suspensions without streptococci, or with streptococci killed by heat. The disintegrated leucocytes appeared as faintly stained forms, without demonstrable nuclei. After longer incubation the leucocytes in the control tubes underwent similar changes, due to autolysis.

The lysis of leucocytes by living streptococci could be more readily demonstrated if broth instead of saline solution were used for washing the streptococci and leucocytes and for the final suspension in the experiment just outlined. Leucocytes suspended in broth do not autolyze for many hours. Hence there was a definite contrast between the disintegrated leucocytes in the suspensions with living streptococci and the healthy leucocytes in the control suspensions. The contrast was marked after three or four hours' incubation. After 21 hours' incubation no recognizable leucocytes could be found in smears of the growing streptococcus cultures, whereas those in smears from the control tubes were fairly well stained.

If leucocytes were suspended in a filtrate of broth culture of hemolytic streptococci they retained their staining properties as well as if suspended in broth. Hence it may be stated that no demonstrable toxic substance is excreted into broth by growing streptococci

[4] The scarlet fever strain known as Dick I was used in these tests.

when judged by the effect of the filtrate on the staining properties of the leucocytes.

THE BIOSCOPIC TEST

The bioscopic test of Neisser and Wechsberg is the most delicate test for determining whether leucocytes have been injured. In this test the vitality of the leucocytes is measured by their capacity for reducing methylene blue to the colorless reductant.

The test was carried out as follows: A suspension of washed leucocytes was obtained in the same manner as that employed for the phagocytic test. One-half of a cubic centimeter of heavy leucocyte suspension (the yield from one rabbit in 6 or 8 cubic centimeters of broth) were added to 2 cubic centimeters of the test or control solution in 1 by 7 millimeter reagent tubes, with 2 drops of 0.5 per cent aqueous solution of methylene blue. A uniform suspension was obtained by drawing the mixture into a pipette; then the contents of the tubes were covered with a layer of 0.5 cubic centimeter of liquid petrolatum. Control tubes were always set up without leucocytes to show that there was nothing in the test fluid which would bring about the reduction of methylene blue. The rack of tubes was placed in a 37° C. water bath, and readings were made at intervals up to two hours.

The demonstration of a toxic substance by the bioscopic test.—The bioscopic test was used to demonstrate substances injurious to leucocytes in scarlet fever skin toxin, in filtrates of young broth cultures of hemolytic streptococci, and in filtrates of cultures in broth with various additions. Kidney tissue, blood serum, washed leucocytes or washed erythrocytes from rabbits were added to broth at different times to determine their possible influence on the production of leucocidic substances. The tests were usually made with filtrates of 24-hour cultures, although it was found that the results were the same when tests were made with filtrates of older cultures. The strain known as Dick I was used in the preparation of filtrates for some of the tests and a strain, No. 663, freshly isolated from the throat in a case of scarlet fever was used for the preparation of filtrates for other tests. The two strains gave the same results.

TABLE 5.—*Protocol of bioscopic tests showing that a trace of toxic substance is excreted into broth by growing hemolytic streptococci*

Leucocytes were suspended in—	Incubated for—		
	30 minutes	1 hour	2 hours
Broth, pH 7.0	Complete reduction		
Scarlet-fever toxin	Partial reduction	Complete reduction	
Filtrate of broth culture	do	do	
Broth with acetic acid, pH 4.8	No reduction	No reduction	No reduction.

TABLE 6.—*Protocol of bioscopic tests showing that the addition of kidney tissue, blood serum, or washed leucocytes does not influence the production of toxic substance, whereas it is produced abundantly in broth containing washed erythrocytes*

Leucocytes were suspended in—	Incubated for—		
	30 minutes	1 hour	2 hours
Broth	Complete reduction		
Filtrate of broth culture	Partial reduction	Complete reduction	
Filtrate of culture in broth plus kidney tissue.	do	do	
Filtrate of culture in broth plus blood serum	do	do	
Filtrate of culture in broth plus washed leucocytes.	do	do	
Filtrate of culture in broth plus washed erythrocytes.	No reduction	No reduction	No reduction.

The results of repeated tests are summarized in Table 5. Broth adjusted to a reaction of pH 4.8, by the addition of acetic acid, was included among the test substances to compare the effect of the toxic substance in question with that of a known toxic substance. The acetic acid completely inhibited reduction. The table shows that the leucocytes suspended in broth completely reduced the methylene blue in 30 minutes, whereas leucocytes suspended in scarlet fever skin toxin[5] or in filtrates of young broth cultures partially reduced the methylene blue in 30 minutes, with complete reduction within an hour. This delay of reduction always occurred in tests with leucocytes suspended in the toxin or filtrates of young broth cultures, as compared with leucocytes suspended in broth. The data thus obtained with the bioscopic test show that there is a trace of leucocidic substance produced in broth by growing hemolytic streptococci. It may be recalled that no trace of this leucocidic substance could be detected by the phagocytic test, nor in microscopic preparations of treated leucocytes.

An effort was made to find some substance available to streptococci when they grow as parasites which might promote an excretion into the medium of the leucocidic substance. The data are presented in Table 6, which shows that the addition to broth of kidney tissue, blood serum, or washed leucocytes did not influence the production of leucocidic substance in the culture medium. In repeated tests the delay of reduction was the same for leucocytes suspended in filtrates of cultures grown in these media as for leucocytes suspended in filtrates of broth culture. On the other hand, the addition of washed erythrocytes to the broth markedly promoted the production of a toxic substance. There was no reduction of methylene blue during the two hours of observation when leucocytes were suspended in filtrate of culture in broth to which washed red cells (10 per cent of red cell suspension in which the washed cells were supsended in broth to make the original volume of blood) had been added.

[5] This was the same sample of toxin which was used in the phagocytic tests. It had a titer of approximately 60,000 skin-test doses per cubic centimeter.

The enhanced production of leucocidic substance in broth plus washed red cells was confirmed in microscopic preparations of leucocytes suspended in the filtrate of such a culture, as compared with those suspended in broth or filtrate of broth culture. There was definitely a more rapid disintegration of leucocytes suspended in the filtrate of culture in broth plus washed red cells than in the control tubes. Thus it was demonstrated by the observation of disintegration of leucocytes in microscopic preparations as well as by the bioscopic test, that a leucocidic substance is produced by streptococci from red blood cells.

Does serum contain an agent for the neutralization of the leucocidic substance? Bioscopic tests were carried out to determine whether normal or immune serum contains an agent to neutralize the leucocidic substance. In these tests 0.5 cubic centimeter of serum was added to 1.5 cubic centimeters of the test or control fluid, and the mixture was incubated for an hour and a half; then a suspension of leucocytes and methylene blue were added as for the bioscopic tests previously described. These tests were carried out with the recently isolated scarlet fever strain of streptococcus used in previous experiments (No. 663), and with homologous immune serum of high agglutinating titer prepared with formalin killed antigen (2 serums) or with one dose of living antigen following a course of treatment with killed antigen (1 serum).

Normal serum is a better medium than broth to maintain the vitality of leucocytes, as can be demonstrated by the slightly more prompt reduction of methylene blue in broth plus 25 per cent of serum than in broth. Neither the normal nor the immune serum could be shown to enhance the reduction of methylene blue by leucocytes exposed to the leucocidic substance further than the slight advantage which was given by adding serum to the broth control. There was, therefore, no demonstrable specific neutralizing agent in either the normal or the immune serum.

THE NATURE OF THE LEUCOCIDIC SUBSTANCE

The thermolability of the substance toxic for leucocytes in the filtrate of culture in broth plus red cells was determined by means of the bioscopic test. The thermolability of the trace of leucocidic substance in scarlet fever toxin and in filtrates of young broth cultures was also determined by the same method and was found to be identical with that of the stronger leucocidic substance produced at the expense of erythrocytes. Presumably the same leucocidic substance is produced under the varying conditions. Temperatures of 37° C. for a day or under 56° C. for one hour do not affect it. There is slight destruction at 56° for one hour, and more with increasing temperatures up to 75° for one hour, at which temperature destruction

is almost complete. No trace of the leucocidic substance could be found after heating at 85° C. for one hour.

The thermolability of the leucocidic substance produced by hemolytic streptococci as reported here agrees with Van de Velde's leucocidin. He stated that the staphylococcal leucocidin is destroyed at about 58° C. There is, however, an objection to the application of the term "leucocidin" to the leucocidic substance produced by streptococci. Several authors (Eijkman; M'Leod and Govenlock; Rogers) have reported that streptococci as well as other bacteria produce a thermolabile substance which inhibits the growth of the homologous organism or other bacteria. This substance has been called "bactericidin." There is no evidence at hand to show whether or not the so-called bactericidin is identical with the leucocidic substance.

The injury done to leucocytes by the thermolabile toxic substance is quite different from that done by acid. Leucocytes injured beyond recovery by acid retain their morphology and staining properties, whereas leucocytes injured by the thermolabile toxic substance are disintegrated.

IS THE LEUCOCIDIC SUBSTANCE IDENTICAL WITH HEMOLYSIN?

Two lines of evidence are offered to show that the leucocidic substance produced by streptococci is not identical with hemolysin: (1) They differ in thermolability; (2) under certain conditions of growth the production of the leucocidic substance is enhanced, whereas under those same conditions hemolysin production is inhibited.

According to M'Leod and M'Nee hemolysin is destroyed by heating a few hours at 37° C. Their observations on the extreme theremolability of the streptococcal hemolysin were confirmed in this study. Hemolysin was destroyed by heating overnight at 37° C. or by heating one hour at 45° C.

Since the leucocidic substance is uninjured at 37° C. for a day, or at 45° for one hour, a filtrate of broth culture containing a vigorous hemolysin can be heated to destroy all the hemolysin without injuring the trace of leucocidic substance which it contains.

If the leucocidic substance were identical with hemolysin there should be an evident correlation between the vigor of action on the two types of blood cells manifest by filtrates of cultures grown under various conditions. A filtrate containing strong hemolysin should also contain strong leucocidic substance and vice versa. Hence if leucocidin and hemolysin were identical, there should be a much stronger content of hemolysin in the filtrate of culture in broth plus red cells than in the filtrate of broth culture, for it was shown (Table 6) that the filtrate of culture in broth plus red cells contains definitely

more leucocidic substance than the filtrate of broth culture. The facts, however, are contrary to that supposition. Experiments were carried out which showed that erythrocytes added to broth not only fail to enhance the production of hemolysin by *Streptococcus scarlatinae* (the "Dick I" strain was used), but they even inhibit its production as compared with the production of hemolysin in broth without red cells.

TABLE 7.—*Protocol showing that erythrocytes in broth culture of* Streptococcus scarlatinae *interfere with the production of hemolysin*

Tube No.	Erythrocyte suspension	Test fluid	Hemolysis as determined by appearance of tubes before centrifugation	Erythrocytes remaining after incubation and centrifugation	Color readings after the erythrocytes were hemolysed in 10 cubic centimeters of water
1	0.4 cubic centimeter.	Broth (control)	No hemolysis	0.2 cubic centimeter sediment.	Deep red.
2	0.1 cubic centimeter.	Broth (control)	do	0.05 cubic centimeter sediment.	Pale red.
3	0.4 cubic centimeter.	Filtrate of broth culture.	Complete hemolysis.	Slight colorless sediment.	Very faint tinge of color.
4	0.1 cubic centimeter.	Filtrate of broth culture.	do	No sediment	No color.
5	0.4 cubic centimeter.	Filtrate of culture in broth+erythrocytes.	Readings could not be made.	0.16 cubic centimeter sediment.	Color is almost as deep as in (1). The distinction is questionable.
6	0.1 cubic centimeter.	Filtrate of culture in broth+erythrocytes.	Readings could not be made.	0.025 cubic centimeter sediment.	Color is not quite so deep as in (2).

The usual color test for hemolysin was not applicable to its determination in filtrates of cultures in broth containing erythrocytes, because the red color of the filtrate made comparative readings impossible in the final test. Hence the amount of hemolysis in the various experimental fluids was determined by measuring the amount of erythrocytes remaining. In the first experiment to compare the hemolysin content of a filtrate of streptococcus culture in broth with that in broth to which erythrocytes (rabbit) were added, the test for hemolysin was made with both rabbit and human erythrocytes, with identical results. There was very little, if any, hemolysis in the filtrate of culture in broth plus erythrocytes, whereas vigorous hemolysis occurred in the filtrate of broth culture. The experiment was repeated and the results are given in Table 7. Cultures were grown overnight in broth, and in broth containing the washed erythrocytes from 10 cubic centimeters of rabbit blood in 50 cubic centimeters of broth. After filtration, 10 cubic centimeters of the various test fluids were measured into graduated centrifuge tubes, and washed rabbit erythrocytes were added. Control tests were made in broth. To one series of tubes 0.4 cubic centimeter, and to another series 0.1 cubic centimeter of suspension of washed erythrocytes was added. The tubes were incubated for four hours in a 37° C. water bath, then were transferred to the refrigerator. On the following day, color readings

were made on tubes for which that was possible, then the tubes were centrifugated and the amount of sediment in the tubes was recorded. The supernatant fluid was removed and 10 cubic centimeters of water were added to each tube. After complete hemolysis had occurred, color readings were made again.

The data recorded in Table 7 show that there was only a minute quantity of hemolysin in the filtrate of culture containing erythrocytes, whereas there was abundant hemolysin in the filtrate of broth culture. A comparison of Tables 6 and 7 leads to the conclusion that the leucocidic substance is not identical with hemolysin, because the addition of erythrocytes to broth culture promotes the production of the leucocidic substance, whereas it inhibits the production of hemolysin.

IS THE LEUCOCIDIC SUBSTANCE IDENTICAL WITH SKIN TOXIN?

The thermolability of the leucocidic substance is about the same as that of the scarlet fever skin toxin. Hence, thermolability determinations gave no information as to the unity or duality of the toxic material. Evidence that the leucocidic substance is not the skin toxin was obtained, however, from the irregularity of the ratio of the two substances in various filtrates. It was noted in previous experiments that the delay in reduction of methylene blue by leucocytes was always the same, giving evidence of only a trace of leucocidic substance whether the test was made with skin toxin of a titer of 60,000 skin test doses or with filtrates of 24-hour cultures of any one of the three strains of streptococci used in the tests. Yet the "N. Y. 5" strain is known to produce two or three times as much skin toxin as the "Dick I" strain.

TABLE 8.—*Protocol of bioscopic tests showing that concentrated skin toxin contains less leucocidic substance than the unconcentrated toxin*

Leucocytes suspended in—	Reduction after incubation for —				
	20 minutes	30 minutes	35 minutes	40 minutes	45 minutes
Broth	Complete.				
Purified toxin, pH 8.2, 150,000 s. t. d.	None	Considerable	Almost complete.	Complete	
Purified toxin, pH 7.6, 150,000 s. t. d.	do	do	do	do	
Unpurified toxin, 60,000 s. t. d.	do	Slight	Considerable	Almost complete.	Complete.
Filtrate of culture No. 663	do	do	do	do	Do.
Filtrate of "Dick I" culture	do	do	do	do	Do.

A purified and concentrated preparation of skin toxin offered material for more decisive comparative tests. This toxin, prepared with the "N. Y. 5" strain, was purified and concentrated by precipitations with acetone, alcohol, acetic acid, and alcohol, respectively. The final product contained approximately 150,000 skin test doses

per cubic centimeter. Its H ion concentration was pH 8.2. A portion of the sample was adjusted to pH 7.6 by the addition of a trace of dilute acetic acid, and tests for leucocidic substance were made with both portions. Parallel tests were made with filtrates of 24-hour broth cultures and with the unpurified unconcentrated skin toxin used in previous experiments. A protocol of one of the experiments is given in Table 8. After the beginning of reduction of the methylene blue, readings were made every five minutes in order to detect even slight differences in the amount of leucocidic substance present in the fluids under observation. The two samples of purified toxin of slightly different H ion concentration behaved exactly alike, and the unpurified toxin behaved exactly like the two filtrates of young streptococcus cultures. Reduction was more prompt in the two samples of purified toxin than in the sample of unpurified toxin, although the purified toxin contained two and one-half times as many skin-test doses of toxin per cubic centimeter as the unpurified sample. The experiment was repeated with similar results. The results of these experiments indicate that the leucocidic substance is not identical with skin toxin.

SUMMARY

The results of the experiments may be summed up as follows:

1. Leucocytes are injured by acid. If the injury is not too great, they may be restored to a healthy condition by bathing in blood serum.

2. In filtrates of broth cultures of *Streptococcus scarlatinae* there is a trace of a substance toxic for leucocytes which can be detected by the bioscopic test, but not by the phagocytic test nor by the deterioration of cells as shown in stained microscopic preparations.

3. The addition of kidney tissue, blood serum, or washed leucocytes to broth cultures does not increase the production of the leucocidic substance. On the other hand, the addition of washed erythrocytes to broth cultures definitely promotes its increase.

4. The thermolability of the trace of leucocidic substance in filtrate of broth culture is the same as that of the more abundant leucocidic substance in filtrate of culture in broth plus erythrocytes. Presumably the two substances are identical.

5. A specific neutralizing agent for the leucocidic substance could not be demonstrated in normal or immune serum.

6. Two lines of evidence are offered which show that the leucocidic substance is not identical with hemolysin.

(*a*) They differ in thermolability.

(*b*) There is no correlation of toxicity for the two types of blood cells manifest by filtrates of cultures grown under varying conditions.

7. The decrease of leucocidic substance in purified and concentrated skin toxin indicates that leucocidic substance and skin toxin are not identical.

REFERENCES

Bordet, Jules (1909): Studies in Immunity, p. 37. New York.

Channon, Hilda A., and M'Leod, J. W. (1929): On the Importance of Thermolabile Streptococcal Toxin, with Special Reference to Its Cytolytic Effect on Leucocytes. J. Path. and Bact., Edinburgh, **32**: 283–291.

Colebrook, L. (1925): Discussion on the Treatment of Septicaemia. Proc. Roy. Soc. Med. (London), **18**: 64–70.

Cross, Howard B. (1921): An Experimental Study of Phagocytosis in Relation to Terminal Infections. Johns Hopkins Hosp. Bull. (Baltimore), **32**: 350–359.

Dold, H. (1930): Über in vitro nachweisbare Zell- und Organgifte aus Streptokokken (Leukozidin, allgemeine Cytozidine, Organozidine). Arch. f. Hyg. (Munich & Berlin), **103**: 10–19.

Downie, A. W. (1930): Experimental Streptococcal Infection and Immunity. J. Path. and Bact. (Edinburgh), **33**: 563–606.

Eijkman, C. (1904): Ueber thermolabile Stoffwechselprodukte als Ursache der natürlichen Wachstumshemmung der Mikroorganismen. Central. f. Bakt. (Jena), I Abt. **37**: 436–449.

Evans, Alice C. (1922): The Toxicity of Acids for Leucocytes, as Indicated by the Tropin Reaction. J. Immunol. (Baltimore), **7**: 271–304.

Hare, Ronald (1928): On the Phagocytosis of Haemolytic Streptococci of High and Low Virulence by the Blood of Patients Infected with That Organism. Brit. J. Exper. Path. (London), **9**: 337–352.

Langwill, Bertha (1924): The Character of Acids Produced by Hemolytic and Nonhemolytic Streptococci from Pathogenic Sources and from Milk. J. Bact. (Baltimore), **9**: 79–94.

Levaditi, C. (1918): Action leucotoxique du streptocoque des plaies de guerre. Considérations sur le mécanisme de la phagocytose. C. R. Soc. de Biol. (Paris), **81**: 1064–1067.

M'Leod, James Walter (1915): Criteria of Virulence Amongst Streptococci, with Some Remarks on Streptococcal Leucocidin. J. Path. and Bact. (Edinburgh), **19**: 392–416.

M'Leod, J. W., and Govenlock, P. (1921): The Production of Bactericidins by Micro-Organisms. Lancet (London), **200**: 900–903.

M'Leod, J. W., and M'Nee, J. W. (1913): On the Anaemia Produced by the Injection of the Hemolysin Obtained from Streptococci, and on the Question of Natural and Acquired Immunity to streptolysin. J. Path. and Bact. (Edinburgh), **17**: 524–537.

Nakayama, Yasushi (1920): On the Toxin for Leucocytes Produced by Streptococci (Streptoleukocidin). J. Inf. Dis. (Chicago), **27**: 86–100.

Neisser, Max, and Wechsberg, Friedrich (1901): Ueber das Staphylotoxin. Zeitsch. f. Hyg. (Leipsic), **36**: 299–349.

Rogers, L. A. (1928): The Inhibiting Effect of Streptococcus lactis on Lactobacillus Bulgaricus. J. Bact. (Baltimore), **16**: 321–325.

Van de Velde, Honoré (1894): Étude sur le mécanisme de la virulence du Staphylocoque pyogène. La Cellule (Louvain), **10**: 401–460.

Watson, A. F., and Wallace, U. (1923): Diphtheria Toxin Production on Douglas Medium. J. Path. and Bact. (Edinburgh), **26**: 447–458.

Wright, Sir Almroth E., Colebrook, L., and Storer, E. J. (1923): New Principles in Therapeutic Inoculation. Lancet (London), **204**: 365–373, 417–420, 473–478.

RAT-FLEA SURVEY OF THE PORT OF ST. THOMAS, VIRGIN ISLANDS

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Available sanitary records of the Virgin Islands do not show that epidemics of plague have ever occurred in any of this group of the West Indies. In view of the fact that epidemics of plague have occurred in neighboring islands, a rat-flea survey of the principal port of the Virgin Islands, St. Thomas, was undertaken to determine the infectibility of this port with plague, as indicated by the *cheopis* index.

During the 1921 epidemic of plague in Porto Rico a strict quarantine was maintained in the Virgin Islands against all Porto Rican ports. The nearest Porto Rican port is only 40 miles from St. Thomas. Fortunately, shipping at that time between these islands consisted mainly of sailing vessels which usually did not dock at St. Thomas, but lay at anchor in the harbor. Nevertheless, quarantine regulations to prevent the introduction of plague were strictly and successfully enforced.

METHOD OF SURVEY

The procedure of the survey was based on similar methods used in New York (1), San Juan (2), and Norfolk (3). Rats were captured alive in cage traps and brought to the quarantine office with the cage uncovered, being handled gently to guard against dislodging any fleas from the rats.

The rats were then killed with chloroform and the fleas collected in accordance with the ingenious method devised by Hasseltine (3) in the Norfolk survey of 1927–28. A small box with a hinged glass top was used for chloroforming the rats. In one end of the box a round hole was cut, which could be closed by a sliding partition. The box was lined with white paper. The cage trap containing the live rat was placed so that the hole for the rat's egress from the trap coincided with the hole in the end of the box. The rat, attempting to escape from the trap, usually went into the box of his own volition. The partition was then slid over the hole, the hinged glass top slightly raised, and gauze saturated with chloroform introduced. The rat when dead, as observed through the window, was removed and combed for fleas. The box was also shaken out to obtain any fleas that might have become dislodged from the rat. No rats escaped.

The fleas were preserved in 95 per cent alcohol and sent to the New York quarantine station for identification of species.

The survey began July 1, 1929, and ended June 30, 1930, being carried on entirely by the regular personnel of the U. S. quarantine station at St. Thomas. During the first four months of the survey the

daily average number of traps was 28; during the last eight months the daily average number was 51.

The town was divided into four zones for purposes of trapping. Zone 1 consisted entirely of the docks where the large vessels are berthed. The dock area is about three-quarters of a mile from the town proper, lying on the opposite side of the harbor, and connected overland by a road skirting the harbor and traversing marshy open land. Zone 2 consisted of all the water front of the town proper. Here the water is shallow, and only sloops and similar small vessels can tie up to the short docks of wood or concrete. The business district skirts this water front. Zone 3 also lies on the water front, but at the extreme western end of the harbor, and comprises a small fishing village, lying about one-half mile from the town itself. Zone 4 consists of the residential district and is made up of three hills sloping upwards rather sharply from the low lying water front and business district.

The docks of zone 1, where the large ships are tied up, are of concrete. The warehouses are constructed of concrete and metal, with a concrete floor and foundation. They afford practically no rat harborage. The buildings of zone 2, are of all types of construction and afford ample rat harborage, as do those of zone 3. The buildings of the residential district are made up of some dwellings built largely of stone, concrete, and masonry, interspersed with others which range from 2-story frame dwellings to mere shacks.

In the vicinity of St. Thomas the soil is hard and rocky, with scant vegetation.

DISTRIBUTION OF RATS

The total number of trap-days was 15,755; the daily average number of traps was 43. During the 365 days of trapping, 312 rats were caught, and a total of 2,113 fleas retrieved. Of the 312 rats, 309 were identified as *Rattus alexandrinus*, and 3 as *Rattus rattus*. None of the species *Rattus norvegicus* was found.

The greatest number of rats were taken in zones 2 and 4, where harborage was found to be most ample. Only three rats were captured in zone 1, which comprised the area of concrete docks and rat-proof warehouses.

Entire absence of the species *Rattus norvegicus* seemed unusual; but this is probably due to two factors. One of these is the absence of suitable harborage for this species. The soil is extremely hard and rocky, precluding much possibility of burrowing refuges. The sewers, most of which are open, are of concrete and masonry, running for comparatively short distances downhill to the sea. The second, and probably the most important factor, is the presence of the mongoose, which overruns the island and is the rat's natural enemy. The

presence of the mongoose and the lack of suitable harborage have probably caused the elimination of all of the rat species not adapted to life in trees or houses.

TABLE 1.—*Distribution of rats and fleas by months*

	Total rats	Rattus alexandrinus		Rattus rattus		Rats per hundred traps days per month	Fleas					Cheopis index
							X. cheopis		Ct. canis or felis		Total	
		Male	Female	Male	Female		Male	Female	Male	Female		
1929												
July	18	14	3	1	------	2.0+	95	66	------	------	161	8.90
August	16	6	10	------	------	1.9—	95	68	------	------	163	10.10
September	17	10	7	------	------	2.0+	93	61	------	------	154	9.05
October	18	13	5	------	------	2.0+	63	50	------	------	113	6.27
November	27	18	9	------	------	1.7+	46	33	2	1	82	2.92
December	19	8	11	------	------	1.2+	45	51	------	------	96	5.00
1930												
January	23	10	13	------	------	1.4+	49	34	------	------	83	3.60
February	31	11	20	------	------	2.1+	92	124	1	------	217	7.0
March	32	19	12	1	------	2.0+	105	160	------	------	265	8.28
April	36	16	20	------	------	2.3+	95	133	------	1	229	6.33
May	39	20	18	------	1	2.4+	119	153	------	------	272	6.98
June	36	18	18	------	------	2.3+	130	148	------	------	278	7.70
Total	312	163	146	2	1	*1.9	1,027	1,081	3	2	2,113	*6.75

* Average.

TABLE 2.—*Distribution of rats and fleas by zones*

Zone	Total number of rats caught	Fleas recovered					Total number of fleas per rat	Total number of X. cheopis per rat
		X. cheopis		Ct. canis or felis		Total		
		Male	Female	Male	Female			
1	3	8	9	------	------	17	5.7	5.7
2	134	462	485	1	1	949	7.09	7.08
3	42	96	118	------	------	214	5.00	5.00
4	133	495	435	2	1	933	7.00	7.00
Total	312	1,061	1,047	3	2	2,113	6.77	6.75

Table 1 shows the distribution of rats and fleas by months, Table 2 presents the distribution by zones, and Chart 1 shows the relations of temperature, rainfall, "rat take" by months, and *cheopis* index. As no data of relative humidity were obtainable, the amount of rainfall by months was substituted for this factor.

DISTRIBUTION OF FLEAS

A total number of 2,113 fleas was recovered from 312 rats. Of this number 2,108, or 99.7 per cent, were identified as *Xenopsylla cheopis*, and 5, or 0.3 per cent as *Ctenocephalus felis* or *canis*. Relative proportions of male and female are shown in Table 1. The average number of fleas per rat was 6.7, and as *Xenopsylla cheopis* constituted

99.7 per cent of the fleas, the *cheopis* index (4) for all practical purposes may be taken as the same figure, 6.7.

The St. Thomas *cheopis* index of 6.7 is only slightly below the *cheopis* index of 7.05 of San Juan (2), where plague has occurred within the past 9 years. The index is higher than that of New Orleans and other ports of the continental United States.

Factors that influence the prevention of the introduction of plague into this port are the practically rat-proof docks and warehouses, the distance of these docks from the main body of the town, and the character of the shipping entering the port. St. Thomas is largely a bunkering port, the majority of vessels being in port for a few hours only to obtain bunker coal or fuel oil. The greater number of vessels arriving from ports plague-infected, or recently plague-infected, are

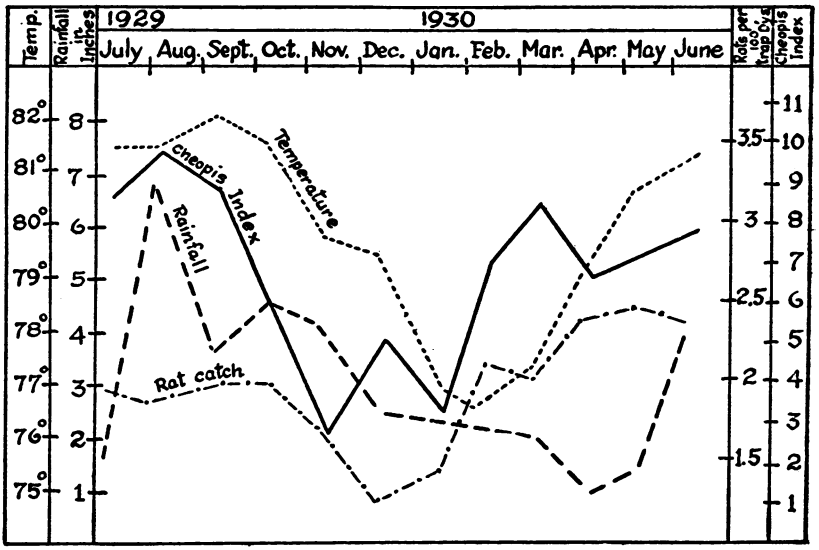

CHART 1.—Graphs showing temperature, rainfall, number of rats caught per 100 trap days, and cheopis index

laden with such cargoes as nitrates, ores, etc., which do not attract rats. Most of these vessels enter under provisional pratique and are required to breast off 4 feet from the dock, apply standard rat guards on all lines, and raise gangways at night. As soon as they have finished coaling, they depart. In the case of vessels from ports badly infected with plague, in addition to these precautions such vessels are allowed alongside the dock only during daylight hours and are kept under strict surveillance.

SUMMARY

1. A rat-flea survey of the port of St. Thomas, Virgin Islands, from July 1, 1929, to June 30, 1930, resulted in the capture of 312 rats, from which 2,113 fleas were taken.

2. Of the 2,113 fleas, 2,108, or 99.7 per cent, were identified as *Xenopsylla cheopis*, and 5, or 0.3 per cent, as *Ctenocephalus canis* or *felis*.

3. On the basis of the figures obtained, the average rat-flea index for the period was 6.7, which was approximately the *Xenopsylla cheopis* index.

4. The *cheopis* index was high throughout the year, but relatively highest during the summer months (March to September, inclusive) and varied in direct relation to temperature and rainfall.

5. *Rattus alexandrinus* was found to be the predominating rat. None of the species, *Rattus norvegicus*, was found.

6. It would seem that, should plague be introduced, it would spread rapidly, as all conditions appear favorable for its propagation.

7. All possible precautions are being taken to prevent the introduction of plague by shipping, and the local sanitary authorities, advised of the result of the survey, are making efforts toward a rat-eradication campaign.

ACKNOWLEDGMENTS

It is desired to express appreciation and acknowledge indebtedness to Medical Director Carroll Fox, of the United States Public Health Service, in charge of the New York quarantine station, and to Surg. C. L. Williams, of the United States Public Health Service, in charge of the laboratory at that station, for their kindness and cooperation in making the identification of species of fleas. To them belongs the credit for the truly scientific part of the survey.

REFERENCES

(1) Fox, Carroll, and Sullivan, E. C.: A comparative study of rat-flea data for several seaports of the United States. Pub. Health Rep., vol. 40, September 11, 1925, pp. 1909–1934.

(2) Cox, O. H., Carrion, Arturo L., and Fox., Carroll: Rat-flea survey of the port of San Juan, Porto Rico. A preliminary report. Pub. Health Rep., vol. 43, March 16, 1928, pp. 611–616.

(3) Hasseltine, E. H.: Rat-flea survey of the port of Norfolk, Va. Pub. Health Rep., vol. 44, March 15, 1929, pp. 579–589.

(4) Grubbs, S. B.: Bubonic plague and maritime quarantine. Pub. Health Rep., vol. 42, August 12, 1927, pp. 2045–2056.

COURT DECISION RELATING TO PUBLIC HEALTH

Law prohibiting the adulteration of coffee upheld.—(United States Circuit Court of Appeals, First Circuit; Gonzalez *v.* People of Porto Rico, 51 F. (2d) 61; decided June 29, 1931.) Section 1 of act 24 of the 1928 acts of Porto Rico provided as follows:

SECTION 1. It shall be illegal to adulterate or to mix coffee, in the grain, ground or pulverized, with any other grain or substance with the intention of selling it, or to offer or have it for sale, and it shall be equally illegal for said

coffee, so adulterated or mixed, to be sold, offered or had for sale, or that it be transported or stored for the purpose of using it for human consumption, or to use it for industrial purposes, when intended for the preparation of food for human consumption.

In a prosecution for a violation of this act, it was charged that the appellant (defendant in the trial court) "unlawfully, willfully, and maliciously had and offered for sale * * * coffee roasted and ground, adulterated with another substance known as sugar." A conviction was had and this conviction was sustained by the Supreme Court of Porto Rico. On appeal to the circuit court of appeals, the contentions of appellant were (1) that the facts alleged in the information, admitted and found, did not constitute a public offense because section 1 was unconstitutional, and (2) that section 1 was invalid because in conflict with the Federal food and drugs act, which act allowed harmless adulterations provided the container or package bore a label stating the substance with which the article was adulterated and the percentage of the adulteration. The adulteration in the instant case was not injurious to health and the package bore a label stating that the coffee was mixed with 4½ per cent of sugar.

The statement by the Supreme Court of Porto Rico as to the object of the law was quoted by the circuit court of appeals as follows:

> The purpose of the law was to protect the public against fraud and deceit by discouraging the admixture of cheaper or inferior grain or other substance, whether wholesome or unwholesome, which would increase the weight and impair the quality of coffee as such.

The appellate court then proceeded to hold that the legislature had acted within its constitutional powers in enacting the statute.

With respect to the appellant's second contention, the circuit court of appeals took the view that the court below had not erred "in holding that the national food and drugs act did 'not forbid the enactment of any local law prohibiting the manufacture of, or traffic in, food or other things'; and that there was 'no conflict between that statute and the law now under consideration.'"

DEATHS DURING WEEK ENDED OCTOBER 3, 1931

Summary of information received by telegraph from industrial insurance companies for the week ended October 3, 1931, and corresponding week of 1930. (From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce)

	Week ended Oct. 3, 1931	Corresponding week, 1930
Policies in force	74,736,758	75,450,406
Number of death claims	13,577	12,460
Death claims per 1,000 policies in force, annual rate	9.5	8.6
Death claims per 1,000 policies, first 40 weeks of year, annual rate	9.8	9.7

Deaths [1] from all causes in certain large cities of the United States during the week ended October 3, 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 midyear population estimates derived from the 1930 census]

City	Week ended Oct. 3, 1931				Corresponding week, 1930		Death rate [2] for the first 40 weeks	
	Total deaths	Death rate [2]	Deaths under 1 year	Infant mortality rate [3]	Death rate [2]	Deaths under 1 year	1931	1930
Total (82 cities)	6,593	9.6	584	[4] 46	10.0	660	12.0	12.0
Akron	37	7.5	6	59	9.4	5	7.8	7.9
Albany [5]	27	10.9	1	20	9.8	3	13.8	14.9
Atlanta	72	13.5	9	92	11.7	9	15.2	15.7
White	39		5	70		4		

Deaths from all causes in certain large cities of the United States during the week ended October 3, 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 Oct. 3, 1931				Corresponding week, 1930		Death rate [2] for the first 40 weeks	
	Total deaths	Death rate	Deaths under 1 year	Infant mortality rate	Death rate	Deaths under 1 year	1931	1930
Milwaukee	97	8.6	5	22	8.8	11	9.4	9.7
Minneapolis	78	8.6	6	39	9.5	3	11.3	10.7
Nashville	41	13.7	8	119	15.9	10	17.0	16.6
White	20		4	80		4		
Colored	21	(6)	4	236	(6)	6	(6)	(6)
New Bedford [7]	28	13.0	2	53	11.1	0	12.2	11.0
New Haven	29	9.3	0	0	11.9	7	12.4	12.8
New Orleans	102	11.4	11	60	15.2	15	17.0	17.4
White	65		6	50		8		
Colored	37	(6)	5	81	(6)	7	(6)	(6)
New York	1,154	8.5	109	46	8.4	99	11.3	10.9
Bronx Borough	153	6.0	11	25	6.0	10	8.3	8.0
Brooklyn Borough	409	8.1	50	53	7.7	41	10.4	9.9
Manhattan Borough	422	12.1	39	66	11.8	32	17.0	16.1
Queens Borough	131	5.9	7	19	6.3	13	7.3	7.1
Richmond Borough	39	12.4	2	36	13.7	3	13.9	14.4
Newark, N. J.	70	8.2	5	26	10.8	10	11.7	12.1
Oakland	64	11.4	4	51	12.2	4	10.6	11.0
Oklahoma City	23	6.1	4	55	7.8	2	10.9	10.8
Omaha	52	12.5	4	45	16.0	3	13.9	13.7
Paterson	34	12.8	8	138	13.5	6	13.4	12.4
Peoria	25	12.0	4	105	7.4	1	12.6	12.4
Philadelphia	363	9.6	26	38	10.6	36	13.2	12.7
Pittsburgh	125	9.6	17	59	10.6	18	14.6	13.8
Portland, Oreg.	72	12.2	1	12	10.0	2	11.6	12.1
Providence	56	11.5	8	74	13.4	7	12.8	13.1
Richmond	41	11.6	3	44	11.1	2	15.7	14.9
White	25		1	22		1		
Colored	16	(6)	2	87	(6)	1	(6)	(6)
Rochester	66	10.4	9	82	9.2	2	12.0	11.5
St. Louis	157	9.9	14	47	9.9	12	15.3	14.2
St. Paul	41	7.7	5	52	9.2	2	10.8	10.1
Salt Lake City [5]	26	9.5	3	45	7.8	0	12.2	12.2
San Antonio	68	14.8	9		8.7	4	14.6	16.7
San Diego	48	16.0	2	41	12.2	3	13.7	14.4
San Francisco	164	13.2	3	20	12.1	6	13.1	13.1
Schenectady	15	8.1	0	0	12.5	3	10.5	11.4
Seattle	79	11.1	4	38	10.1	2	11.4	10.9
Somerville	14	6.9	1	37	9.5	1	9.0	9.8
South Bend	18	8.7	2	50	9.4	5	8.1	8.9
Spokane	20	9.0	1	26	13.1	2	12.4	12.4
Springfield, Mass.	35	12.0	1	15	11.8	2	11.8	12.2
Syracuse	29	7.1	0	0	10.2	3	11.6	11.6
Tacoma	20	9.7	2	51	10.2	1	12.0	12.5
Toledo	79	13.9	5	46	12.5	12	12.0	12.7
Trenton	19	8.0	1	17	14.8	4	16.5	16.6
Utica	26	13.2	1	26	11.3	1	14.1	14.8
Washington, D. C.	128	13.5	13	72	12.1	17	15.9	15.1
White	83		6	49		8		
Colored	45	(6)	7	120	(6)	9	(6)	(6)
Waterbury	8	4.1	0	0	7.3	1	9.7	9.8
Wilmington, Del. [7]	22	10.8	3	65	11.7	6	14.0	14.5
Worcester	38	10.0	5	69	11.5	3	12.1	12.8
Yonkers	13	4.9	0	0	8.9	1	8.6	8.1
Youngstown	24	7.2	4	56	10.4	5	10.2	10.3

[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 77 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, Kan., 14; Knoxville, 15; Louisville, 17; Memphis, 33; 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 October 10, 1931, and October 11, 1930

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended October 10, 1931, and October 11, 1930

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930
New England States:								
Maine	4	2	1	7	46	----	0	0
New Hampshire	1	10	----	----	1	----	0	0
Vermont	----	4	----	----	1	----	0	0
Massachusetts	56	47	4	6	22	28	1	1
Rhode Island	2	25	----	----	53	1	0	0
Connecticut	6	5	1	2	11	9	1	0
Middle Atlantic States:								
New York	80	75	[1] 2	[1] 7	58	52	5	10
New Jersey	15	63	4	5	2	34	4	2
Pennsylvania	81	90	----	----	118	52	7	2
East North Central States:								
Ohio	111	44	7	8	2	10	1	3
Indiana	36	41	----	4	7	2	1	3
Illinois	79	131	62	24	8	17	4	3
Michigan	29	47	2	1	25	36	4	10
Wisconsin	16	24	14	25	12	67	2	3
West North Central States:								
Minnesota	15	13	----	----	2	7	3	1
Iowa	6	9	----	----	1	4	1	1
Missouri	73	43	1	2	1	32	2	3
North Dakota	5	2	----	----	18	8	1	0
South Dakota	17	13	----	----	9	1	1	1
Nebraska	17	9	----	----	----	7	0	0
Kansas	19	18	3	1	10	1	1	1

[1] New York City only.

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended October 10, 1931, and October 11, 1930—Continued

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930
South Atlantic States:								
Delaware	4					1	0	0
Maryland [2] [3]	68	32	6	5	3	5	0	1
District of Columbia	10	22			1	2	2	0
Virginia								
West Virginia	55	28	19	8	9	15	3	0
North Carolina	199	173	2	10	14	3	2	0
South Carolina [3]	32	58	154	251	4		1	3
Georgia [3]	32	21	11	24		10	0	0
Florida [3]	18	13	1		16	1	0	0
East South Central States:								
Kentucky	175	9				37	2	0
Tennessee	171	60	5	16	1	6	2	8
Alabama	101	62		20	11	28	4	1
Mississippi	138	38					0	0
West South Central States:								
Arkansas	44	12		15	3	1	0	0
Louisiana	22	14	3	1	2	1	0	0
Oklahoma [4]	99	66	2	1		5	0	3
Texas	35	25	12	12	2	2	0	0
Mountain States:								
Montana	1	6			10		0	1
Idaho	3				2	6	0	0
Wyoming		1			1		0	0
Colorado	11	7			3	27	1	1
New Mexico	9	11				5	0	1
Arizona	6	9	7	1	1	9	2	4
Utah [3]	1	2		4	1	1	0	0
Pacific States:								
Washington	6	22			7	2	0	3
Oregon	1	2	22	6	6	21	1	1
California	61	55	73	26	71	62	3	2

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930
New England States:								
Maine	8	16	9	6	0	0	3	5
New Hampshire	3	2	5	2	0	0	1	0
Vermont	6	0	4	2	1	0	2	0
Massachusetts	72	53	151	87	0	0	12	9
Rhode Island	5	2	7	5	0	0	0	1
Connecticut	45	10	9	16	0	0	5	11
Middle Atlantic States:								
New York	239	51	184	111	0	0	35	35
New Jersey	50	9	54	49	0	0	12	11
Pennsylvania	40	9	187	141	0	0	69	139
East North Central States:								
Ohio	8	56	178	174	0	3	57	49
Indiana	5	14	48	81	3	8	12	15
Illinois	61	27	178	193	16	9	51	28
Michigan	74	15	102	119	2	2	20	33
Wisconsin	49	16	22	62	1	0	3	3
West North Central States:								
Minnesota	58	13	36	33	0	3	3	1
Iowa	13	21	31	39	5	15	5	2
Missouri	7	27	107	42	8	10	15	24
North Dakota	1	0	19	12	5	3	5	4
South Dakota	0	24	7	8	2	5	8	1
Nebraska	1	15	18	14	1	9	1	6
Kansas	1	57	46	41	2	3	13	13

[2] Week ended Friday.

[3] Typhus fever, 1931, 11 cases: 1 case in Maryland, 2 cases in South Carolina, 6 cases in Georgia, and 2 cases in Florida.

[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 October 10, 1931, and October 11, 1930—Continued

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930	Week ended Oct. 10, 1931	Week ended Oct. 11, 1930
South Atlantic States:								
Delaware	1	0	5	4	0	0	2	10
Maryland [2 3]	5	3	61	33	0	0	33	54
District of Columbia	3	1	15	10	0	0	9	5
Virginia	1							
West Virginia	3	3	43	48	0	1	79	58
North Carolina	7	1	111	109	3	0	23	23
South Carolina [3]	0	1	9	22	0	0	22	46
Georgia [3]	0	3	34	32	2	0	28	37
Florida [3]	0	0	0	6	0	1	3	3
East South Central States:								
Kentucky	1	3	68	27	0	5	68	30
Tennessee	3	5	63	54	1	2	30	41
Alabama	0	3	66	66	0	1	33	15
Mississippi	0	2	40	26	1	1	27	19
West South Central States:								
Arkansas	0	4	23	7	1	5	19	45
Louisiana	1	3	17	9	2	0	40	21
Oklahoma [4]	0	8	34	47	1	2	56	37
Texas	0	10	39	11	5	11	36	11
Mountain States:								
Montana	7	1	10	26	0	0	9	5
Idaho	0	0	10	6	8	0	4	5
Wyoming	0	2	5	4	0	0	1	0
Colorado	1	4	12	8	0	1	1	19
New Mexico	4	2	7	9	0	1	14	19
Arizona	1	1	1	3	0	0	2	13
Utah [2]	0	0	6	11	1	0	4	1
Pacific States:								
Washington	10	1	26	40	5	10	4	12
Oregon	0	0	8	11	1	0	3	3
California	6	57	67	75	9	22	15	13

[2] Week ended Friday.
[3] Typhus fever, 1931, 11 cases: 1 case in Maryland, 2 cases in South Carolina, 6 cases in Georgia, and 2 cases in Florida.
[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
September, 1931										
Alabama	5	299	13	373	26	110	10	156	3	127
Arizona	4	16	13	1	10	2	2	15	0	27
Connecticut	2	20	7	1	17		458	26	0	23
Indiana	5	56	46		28		12	112	31	66
Iowa	4	33			9		34	50	17	14
Maine	2	13	1		36		20	18	0	18
Michigan	24	73	4	1	59		577	285		97
North Dakota	4	5			7		11	15	6	17
Porto Rico		44	73	2,840	11		1		0	11

September, 1931

Chicken pox:	Cases
Alabama	21
Arizona	5
Connecticut	32
Indiana	21
Iowa	17
Maine	11
Michigan	85
North Dakota	9
Porto Rico	3

Conjunctivitis, infectious:	Cases
Connecticut	1
Maine	1
Dengue:	
Alabama	1
Dysentery:	
Arizona	5
Connecticut (bacillary)	1
Porto Rico	45
Filariasis:	
Porto Rico	8

German measles:	Cases
Arizona	1
Connecticut	9
Iowa	2
Maine	5
Lead poisoning:	
Connecticut	2
Leprosy:	
Porto Rico	1
Lethargic encephalitis:	
Alabama	4
Connecticut	3
Michigan	8
Mumps:	
Alabama	13
Arizona	7
Connecticut	26
Indiana	22
Iowa	19
Maine	17
Michigan	110
North Dakota	51
Porto Rico	12
Ophthalmia neonatorum:	
Arizona	1
Connecticut	1
Porto Rico	9
Paratyphoid fever:	
Connecticut	4
Porto Rico	1
Puerperal septicemia:	
Porto Rico	6
Rabies in animals:	
Connecticut	4
Rabies in man:	
Alabama	1
Septic sore throat:	
Connecticut	5
Iowa	1
Michigan	7

Tetanus:	Cases
Connecticut	2
Maine	1
Porto Rico	5
Tetanus, infantile:	
Porto Rico	12
Trachoma:	
Arizona	29
North Dakota	2
Porto Rico	6
Trichinosis:	
Connecticut	1
Typhus fever:	
Alabama	5
Maine	18
Undulant fever:	
Alabama	1
Arizona	1
Indiana	1
Iowa	2
Maine	2
Michigan	1
North Dakota	1
Vincent's angina:	
Maine	5
North Dakota	48
Whooping cough:	
Alabama	81
Arizona	3
Connecticut	258
Indiana	120
Iowa	92
Maine	35
Michigan	848
North Dakota	83
Porto Rico	119

Cases of Certain Communicable Diseases Reported for the Month of May, 1931, by State Health Officers

State	Chicken pox	Diphtheria	Measles	Mumps	Scarlet fever	Smallpox	Tuberculosis	Typhoid and paratyphoid fever	Whooping cough
Maine	166	23	68	246	145	0	75	6	103
New Hampshire	----	6	----	----	11	0	----	0	----
Vermont	127	2	69	95	22	18	19	2	42
Massachusetts	1,138	152	2,299	644	1,542	0	491	21	626
Rhode Island	76	20	505	257	226	0	61	2	36
Connecticut	392	39	2,414	276	200	0	105	9	172
New York	2,716	536	12,992	1,744	3,650	32	1,755	72	1,920
New Jersey	1,827	166	4,190	296	1,160	6	489	15	933
Pennsylvania	2,458	297	16,967	1,778	2,600	0	627	45	853
Ohio	1,916	134	5,027	2,511	1,824	192	749	39	431
Indiana	364	81	4,501	205	913	541	931	11	344
Illinois	1,402	481	8,350	1,060	2,149	265	879	25	815
Michigan	1,439	137	787	812	1,697	81	543	16	1,087
Wisconsin	1,941	65	3,442	4,544	624	50	198	4	609
Minnesota	1,032	52	897	----	344	33	288	8	256
Iowa	186	24	271	105	237	274	34	1	108
Missouri	305	160	2,419	198	1,340	212	282	35	300
North Dakota	131	30	302	113	145	22	16	5	51
South Dakota	72	41	186	10	52	59	20	3	43
Nebraska	329	26	49	655	198	233	20	3	111
Kansas	335	46	497	557	170	284	136	10	176

Cases of Certain Communicable Diseases Reported for the Month of May, 1931, by State Health Officers—Continued

State	Chicken pox	Diphtheria	Measles	Mumps	Scarlet fever	Smallpox	Tuberculosis	Typhoid and paratyphoid fever	Whooping cough
Delaware	18	2	539	34	64	0	20	3	13
Maryland	330	47	4,539	313	287	0	[1] 221	24	258
District of Columbia	86	37	1,222	----	76	0	97	3	35
Virginia	642	67	3,605	----	159	13	217	39	461
West Virginia	284	33	646	----	190	27	75	27	274
North Carolina	445	60	3,996	----	169	13	----	17	846
South Carolina	392	82	674	152	28	6	183	47	304
Georgia	179	31	823	175	276	44	127	48	172
Florida	161	19	764	43	20	5	47	12	71
Kentucky [2]	----	----	----	----	----	----	----	----	----
Tennessee	188	42	1,704	164	414	100	263	32	291
Alabama	148	44	1,110	102	100	56	582	38	92
Mississippi	694	33	260	331	78	184	155	45	450
Arkansas	109	10	212	67	50	106	[1] 27	27	68
Louisiana	108	74	22	8	84	74	[1] 163	49	19
Oklahoma [3]	208	42	183	31	108	280	59	24	60
Texas	----	97	----	----	147	----	----	39	----
Montana	167	7	70	80	80	4	48	5	97
Idaho	39	9	22	16	52	10	1	6	109
Wyoming	35	----	6	72	45	2	----	0	32
Colorado	249	21	894	193	136	30	69	3	324
New Mexico	85	14	424	65	25	8	45	8	----
Arizona	26	13	215	15	11	0	93	10	32
Utah [3]	----	----	----	----	----	----	----	----	----
Nevada	22	----	88	4	1	0	1	0	----
Washington	578	36	1,028	264	144	104	227	28	541
Oregon	222	31	424	255	74	90	59	8	75
California	1,710	304	4,780	1,145	554	93	834	45	1,166

[1] Pulmonary. [2] Reports received weekly. [3] Exclusive of Oklahoma City and Tulsa.

Case Rates per 100,000 Population (Annual Basis) for the Month of May, 1931

State	Chicken pox	Diphtheria	Measles	Mumps	Scarlet fever	Smallpox	Tuberculosis	Typhoid and paratyphoid fever	Whooping cough
Maine	244	34	100	362	213	0	110	9	151
New Hampshire	----	15	----	----	28	0	----	0	----
Vermont	415	7	225	310	72	59	62	7	137
Massachusetts	312	42	630	176	422	0	135	6	171
Rhode Island	128	34	852	434	381	0	103	3	61
Connecticut	282	28	1,739	199	144	0	76	6	124
New York	249	49	1,190	160	334	3	161	7	176
New Jersey	518	47	1,189	84	329	2	139	4	265
Pennsylvania	297	36	2,051	215	314	0	76	5	103
Ohio	334	23	876	438	318	33	131	7	84
Indiana	131	29	1,618	74	328	194	335	4	126
Illinois	212	73	1,265	161	326	40	133	4	123
Michigan	340	32	186	192	401	19	128	4	257
Wisconsin	768	26	1,362	1,798	247	20	78	2	241
Minnesota	470	24	408	----	157	15	131	4	117
Iowa	88	11	129	50	113	130	16	0	51
Missouri	98	52	779	64	431	68	91	11	97
North Dakota	225	52	519	194	249	38	28	9	88
South Dakota	121	69	313	17	88	99	34	5	79
Nebraska	279	22	42	556	168	198	17	3	94
Kansas	208	29	309	346	106	176	85	6	109
Delaware	88	10	2,641	167	314	0	98	15	64
Maryland	235	33	3,267	223	204	0	[1] 157	17	184
District of Columbia	205	88	2,919	----	182	0	232	7	84
Virginia	310	32	1,743	----	77	6	105	19	223
West Virginia	190	22	432	----	127	18	50	18	183
North Carolina	161	22	1,450	----	61	5	----	6	307
South Carolina	264	55	455	103	19	4	123	32	205
Georgia	72	13	333	71	112	18	51	19	70
Florida	124	15	588	33	15	4	36	9	55

[1] Pulmonary.

Case Rates per 100,000 Population (Annual Basis) for the Month of May, 1931—Continued

State	Chicken pox	Diphtheria	Measles	Mumps	Scarlet fever	Smallpox	Tuberculosis	Typhoid and paratyphoid fever	Whooping cough
Kentucky [1]									
Tennessee	84	19	757	73	184	44	117	14	129
Alabama	65	19	487	45	44	25	255	17	40
Mississippi	401	19	150	191	45	106	90	26	260
Arkansas	69	6	134	42	32	67	[1] 17	17	43
Louisiana	59	41	12	4	46	41	[1] 90	27	10
Oklahoma [2]	117	24	103	17	61	157	83	13	34
Texas		19			29			8	
Montana	366	15	153	175	175	9	105	11	212
Idaho	103	24	58	42	137	26	8	16	287
Wyoming	180		31	370	231	10		0	164
Colorado	280	24	1,005	217	153	34	78	3	364
New Mexico	232	38	1,158	178	68	22	123	22	
Arizona	68	34	565	39	29	0	244	26	84
Utah [2]									
Nevada	279		1,117	51	13	0	13	0	
Washington	428	27	762	196	107	77	168	21	401
Oregon	268	37	512	308	89	109	71	10	91
California	338	60	946	227	110	18	165	9	231

[1] Pulmonary. [2] Reports received weekly. [3] Exclusive of Oklahoma City and Tulsa.

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 91 cities reporting deaths is more than 31,935,000. The estimated expectancy is based on the experience of the last nine years, excluding epidemics.

Weeks ended October 3, 1931, and October 4, 1930

	1931	1930	Estimated expectancy
Cases reported			
Diphtheria:			
46 States	1,726	1,228	
96 cities	356	377	600
Measles:			
45 States	451	644	
96 cities	116	116	
Meningococcus meningitis:			
46 States	49	77	
96 cities	20	32	
Poliomyelitis: 46 States	956	649	
Scarlet fever:			
46 States	1,607	1,686	
96 cities	419	450	463
Smallpox:			
46 States	105	175	
96 cities	1	5	2
Typhoid fever:			
46 States	1,049	933	
96 cities	135	124	143
Deaths reported			
Influenza and pneumonia: 91 cities	342	366	
Smallpox: 91 cities	0	0	

City reports for week ended October 3, 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	0	0	1	----	0	1	1	4
New Hampshire:								
Concord	0	0	0	----	0	0	0	0
Manchester	0	0	0	----	0	0	0	2
Nashua	0	0	0	----	0	0	0	0
Vermont:								
Barre	0	0	0	----	0	0	0	0
Massachusetts:								
Boston	5	16	12	3	1	2	2	8
Fall River	1	3	2	----	0	4	0	1
Springfield	1	3	0	----	0	0	3	1
Worcester	4	4	0	----	0	0	11	3
Rhode Island:								
Pawtucket	0	1	0	----	0	0	0	1
Providence	0	4	5	----	0	3	1	3
Connecticut:								
Bridgeport	1	3	0	----	0	0	0	3
Hartford	0	2	1	----	0	0	0	0
New Haven	0	0	0	----	0	0	4	1
MIDDLE ATLANTIC								
New York:								
Buffalo	2	9	2	----	0	0	0	10
New York	13	88	41	10	3	10	17	93
Rochester	1	2	1	----	0	3	2	0
Syracuse	0	1	0	----	0	0	0	0
New Jersey:								
Camden	0	3	0	----	0	0	0	0
Newark	1	10	2	2	0	0	0	3
Trenton	0	1	0	----	0	0	3	1
Pennsylvania:								
Philadelphia	4	33	1	3	3	1	4	16
Pittsburgh	3	13	8	----	0	12	8	11
Reading	1	1	0	----	0	0	0	1
EAST NORTH CENTRAL								
Ohio:								
Cincinnati	0	6	4	----	1	0	0	5
Cleveland	8	31	2	2	1	3	12	10
Columbus	1	4	15	----	0	1	1	1
Toledo	0	5	3	----	0	4	0	3
Indiana:								
Fort Wayne	0	1	3	----	0	0	0	0
Indianapolis	0	8	1	----	1	1	1	3
South Bend	0	1	1	----	0	0	0	1
Terre Haute	1	0	1	----	0	0	0	1
Illinois:								
Chicago	8	67	39	1	1	6	10	26
Springfield	1	0	0	----	0	0	0	1

City reports for week ended October 3, 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								
Michigan:								
Detroit	1	39	7	2	0	2	5	5
Flint	0	2	0		0	0	3	2
Grand Rapids	3	1	0		0	1	0	0
Wisconsin:								
Kenosha	0	0	0		0	0	4	0
Madison	0	2	0			1	5	
Milwaukee	9	7	0		0	5	10	3
Racine	1	0	0		0	0	4	0
Superior	0	0	0		0	1	2	0
WEST NORTH CENTRAL								
Minnesota:								
Duluth	1	0	0		0	0	0	1
Minneapolis	17	21	7		2	1	18	1
St. Paul	3	9	3		0	0	0	2
Iowa:								
Davenport	0	1	0			0	0	
Des Moines	0	2	1			0	0	
Sioux City	0	1	3			0	1	
Waterloo	0	0	0			0	0	
Missouri:								
Kansas City	3	4	2		0	0	2	3
St. Joseph	0	0	3		0	0	0	2
St. Louis	2	24	14			0	0	4
North Dakota:								
Fargo	0	1	0		0	0	0	1
Grand Forks	0	0	0			0	0	
South Dakota:								
Aberdeen	16	0	0			5	0	
Nebraska:								
Omaha	0	8	12		0	0	1	4
Kansas:								
Topeka	0	1	1		2	0	3	1
Wichita	2	2	0		0	4	0	1
SOUTH ATLANTIC								
Delaware:								
Wilmington	0	1	0		0	0	0	3
Maryland:								
Baltimore	4	17	13	1	0	1	6	9
Cumberland	0	0	0		0	0	0	0
Frederick	0	0	0		0	0	0	0
District of Columbia:								
Washington	1	11	9		0	0	0	5
Virginia:								
Lynchburg	0	3	5		0	0	0	0
Norfolk	0	2	0		0	0	1	1
Richmond	0	17	14		0	0	0	2
Roanoke	0	3	10		0	0	0	1
West Virginia:								
Charleston	0	1	0	1	0	0	0	0
Wheeling	1	0	0		0	0	0	1
North Carolina:								
Raleigh	0	3	1		0	0	0	1
Wilmington	0	1	1		0	0	0	0
Winston-Salem	0	4	13		0	0	2	0
South Carolina:								
Charleston	0	1	1	7	0	0	0	2
Columbia	0	1	0		0	0	0	5
Greenville	0	2	2		0	0	0	0
Georgia:								
Atlanta	0	7	6	4	0	0	0	2
Brunswick	0	0	0		0	0	1	0
Savannah	0	1	2	3	0	0	0	0
Florida:								
Miami	0	2	0		0	17	1	1
Tampa	0	1	1		0	0	0	0

City reports for week ended October 3, 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								
Kentucky:								
Covington	0	1	1		0	0	0	0
Tennessee:								
Memphis	0	5	15		0	0	0	7
Nashville	0	3	1		0	0	0	0
Alabama:								
Birmingham	0	4	3		1	0	0	3
Mobile	0	1	4		0	0	0	0
Montgomery	0	3	0			5	2	
WEST SOUTH CENTRAL								
Arkansas:								
Fort Smith	0	0	3			1	0	
Little Rock	0	0	0		0	0	0	1
Louisiana:								
New Orleans	0	8	7		0	0	0	8
Shreveport	0	1	3		0	3	0	0
Oklahoma:								
Muskogee	0	0	13		0	0	0	0
Oklahoma City	0	2	3		0	0	0	2
Tulsa	1	2	38			0	1	
Texas:								
Dallas	0	10	7		0	0	0	1
Fort Worth	0	2	5		0	0	0	0
Galveston	0	0	0		0	0	0	1
Houston	0	5	8		0	0	0	5
San Antonio	0	2	4		0	1	0	3
MOUNTAIN								
Montana:								
Billings	0	0	0		0	2	0	0
Great Falls	0	0	0		0	0	0	0
Helena	0	0	0		0	1	0	0
Missoula	0	1	0		0	0	0	1
Idaho:								
Boise	1	1	0		0	0	1	0
Colorado:								
Denver	5	8	7		0	1	0	2
Pueblo	0	0	0		0	0	0	0
New Mexico:								
Albuquerque	1	0	1		0	0	0	1
Arizona:								
Phoenix	0	1	0		0	0	0	1
Utah:								
Salt Lake City	4	2	2		0	0	0	2
Nevada:								
Reno	0	0	0		0	0	0	2
PACIFIC								
Washington:								
Seattle	12	3	0			5	3	
Spokane		2						
Tacoma	0	2	0		0	0	1	4
Oregon:								
Portland	12	5	0		0	2	4	0
Salem	0	0	0		0	0	0	0
California:								
Los Angeles	9	21	19	14	0	12	1	7
Sacramento	0	2	0		0	10	0	2
San Francisco	14	10	2	3	0	13	0	9

City reports for week ended October 3, 1931—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
NEW ENGLAND											
Maine:											
Portland	1	1	0	0	0	0	1	0	0	2	14
New Hampshire:											
Concord	0	2	0	0	0	0	0	0	0	0	8
Manchester	1	0	0	0	0	1	0	0	0	0	35
Nashua	0	1	0	0	0	0	0	0	0	0	----
Vermont:											
Barre	0	0	0	0	0	1	0	0	0	0	2
Massachusetts:											
Boston	24	22	0	0	0	9	3	1	0	16	207
Fall River	2	7	0	0	0	2	1	0	0	2	24
Springfield	2	5	0	0	0	2	0	0	0	2	35
Worcester	5	13	0	0	0	1	0	0	0	9	38
Rhode Island:											
Pawtucket	0	0	0	0	0	0	0	0	0	0	16
Providence	2	3	0	0	0	2	1	4	0	4	56
Connecticut:											
Bridgeport	2	1	0	0	0	0	0	0	0	0	19
Hartford	1	0	0	0	0	3	0	2	0	4	35
New Haven	1	1	0	0	0	3	0	0	0	3	29
MIDDLE ATLANTIC											
New York:											
Buffalo	8	20	0	0	0	11	2	0	0	16	122
New York	36	25	0	0	0	79	32	19	3	166	1,154
Rochester	2	11	0	0	0	1	2	2	0	3	63
Syracuse	2	4	0	0	0	7	0	0	0	16	29
New Jersey:											
Camden	2	3	0	0	0	0	1	0	0	2	22
Newark	5	8	0	0	0	10	2	2	0	79	74
Trenton	1	2	0	0	0	2	0	1	0	0	19
Pennsylvania:											
Philadelphia	27	32	0	0	0	22	11	20	0	91	363
Pittsburgh	17	8	0	0	0	10	3	4	1	35	125
Reading	0	0	0	0	0	0	0	0	0	0	34
EAST NORTH CENTRAL											
Ohio:											
Cincinnati	8	17	0	0	0	9	2	3	0	1	118
Cleveland	15	12	0	0	0	12	3	1	1	73	176
Columbus	4	8	0	0	0	4	1	1	0	2	63
Toledo	5	6	0	0	0	4	1	5	0	31	79
Indiana:											
Fort Wayne	1	0	0	0	0	0	1	0	0	3	19
Indianapolis	6	0	0	0	0	9	2	0	0	0	----
South Bend	2	1	0	0	0	2	0	0	0	2	18
Terre Haute	1	0	0	0	0	0	0	1	0	0	15
Illinois:											
Chicago	45	31	0	0	0	36	6	2	1	101	569
Springfield	1	1	0	0	0	1	0	0	0	0	18
Michigan:											
Detroit	36	17	0	0	0	18	4	5	2	116	217
Flint	7	3	0	0	0	0	0	0	0	8	12
Grand Rapids	6	4	0	0	0	1	1	0	0	0	24
Wisconsin:											
Kenosha	0	0	0	0	0	1	0	0	0	0	4
Madison	1	0	0	0	----	----	0	0	----	3	----
Milwaukee	10	5	0	0	0	3	1	1	0	52	97
Racine	3	2	0	0	0	0	0	0	0	1	8
Superior	1	1	0	0	0	1	0	0	0	0	6

City reports for week ended October 3, 1931—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
WEST NORTH CENTRAL											
Minnesota:											
Duluth	4	0	0	0	0	0	0	0	0	0	18
Minneapolis	21	15	0	0	0	3	1	1	0	6	78
St. Paul	11	4	0	0	0	3	1	0	0	10	45
Iowa:											
Davenport	0	2	0	2			0	0		0	
Des Moines	3	3	0	1			0	0		0	29
Sioux City	2	4	0	0			1	0		2	
Waterloo	2		0				0				
Missouri:											
Kansas City	6	3	0	0	0	11	2	0	0	5	81
St. Joseph	1	1	0	0	0	2	0	1	0	1	22
St. Louis	16	12	0	0	0	7	5	3	0	39	157
North Dakota:											
Fargo	2	2	0	0	0	0	0	0	0	3	5
Grand Forks	1	0	0	0			0	0		0	
South Dakota:											
Aberdeen	1	2	0	0			0	0		8	
Nebraska:											
Omaha	2	4	0	1	0	3	0	1	0	1	52
Kansas:											
Topeka	2	2	0	0	0	1	0	1	0	0	26
Wichita	2	2	0	0	0	0	0	0	0	1	17
SOUTH ATLANTIC											
Delaware:											
Wilmington	1	0	0	0	0	1	0	0	0	0	22
Maryland:											
Baltimore	8	4	0	0	0	21	8	4	0	104	168
Cumberland	0	0	0	0	0	2	1	0	0	0	12
Frederick	0	0	0	0	0	0	0	0	0	0	3
District of Col.:											
Washington	8	6	0	0	0	9	3	0	0	10	128
Virginia:											
Lynchburg	1	0	0	0	0	1	1	2	1	0	11
Norfolk	1	2	0	0	0	2	0	0	0	5	
Richmond	5	15	0	0	0	4	1	2	0	0	44
Roanoke	2	1	0	0	0	1	0	1	0	0	10
West Virginia:											
Charleston	2	1	0	0	0	2	1	[1] 14	1	3	30
Wheeling	2	0	0	0	0	0	0	2	0	1	24
North Carolina:											
Raleigh	1	0	0	0	0	2	0	0	0	2	17
Wilmington	1	0	0	0	0	1	0	0	0	1	12
Winston-Salem	4	1	0	0	0	1	1	0	0	2	17
South Carolina:											
Charleston	0	1	0	0	0	5	2	0	0	0	28
Columbia	1	1	0	0	0	3	0	0	0	0	27
Greenville	0	0	0	0	0	0	0	0	0	0	
Georgia:											
Atlanta	6	0	0	0	0	3	2	7	5	0	72
Brunswick	0	0	0	0	0	0	0	0	0	0	6
Savannah	0	0	0	0	0	3	1	0	0	2	28
Florida:											
Miami	0	0	0	0	0	2	1	1	0	0	22
Tampa	0	0	0	0	0	0	0	1	0	3	16
EAST SOUTH CENTRAL											
Kentucky:											
Covington	1	0	0	0	0	0	0	1	0	0	12
Tennessee:											
Memphis	3	5	0	0	0	9	4	2	0	14	78
Nashville	2	0	0	0	0	3	3	4	0	1	41

[1] 13 cases nonresidents.

City reports for week ended October 3, 1931—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
EAST SOUTH CENTRAL—con.											
Alabama:											
Birmingham	6	3	0	0	0	1	2	2	0	3	60
Mobile	1	1	0	0	0	1	0	0	0	0	21
Montgomery	1	3	0	0	----	----	1	0	----	4	----
WEST SOUTH CENTRAL											
Arkansas:											
Fort Smith	1	0	0	0	----	----	0	0	----	0	----
Little Rock	2	1	0	0	0	2	1	0	1	0	5
Louisiana:											
New Orleans	3	2	0	0	0	11	3	4	1	0	102
Shreveport	1	1	0	0	0	0	0	0	1	3	36
Oklahoma:											
Muskogee	0	0	0	0	0	0	0	1	0	0	----
Oklahoma City	3	1	1	0	0	2	2	0	0	0	23
Tulsa	4	2	0	0	----	----	1	0	----	0	----
Texas:											
Dallas	3	7	0	0	0	1	2	1	0	4	36
Fort Worth	1	9	0	0	0	2	1	5	0	0	24
Galveston	1	0	0	0	0	0	0	0	0	0	8
Houston	1	0	0	0	0	4	1	2	0	0	59
San Antonio	1	0	0	0	0	9	1	0	0	0	68
MOUNTAIN											
Montana:											
Billings	0	0	0	0	0	0	0	0	0	1	7
Great Falls	1	0	0	0	0	0	0	0	0	1	2
Helena	0	0	0	0	0	0	0	0	0	0	4
Missoula	0	1	1	0	0	0	0	1	0	0	3
Idaho:											
Boise	0	1	0	0	0	0	1	0	1	0	7
Colorado:											
Denver	6	8	0	0	0	4	2	1	1	5	66
Pueblo	0	0	0	0	0	0	1	1	0	0	10
New Mexico:											
Albuquerque	0	0	0	0	0	0	2	6	0	0	6
Arizona:											
Phoenix	1	1	0	0	0	2	0	0	0	0	----
Utah:											
Salt Lake City	2	1	0	0	0	2	2	0	0	1	26
Nevada:											
Reno	0	0	0	0	0	0	0	0	0	0	8
PACIFIC											
Washington:											
Seattle	7	7	0	0	----	----	2	1	----	0	----
Spokane	3	----	1	----	----	----	1	----	----	----	----
Tacoma	1	2	1	0	0	0	1	0	0	6	20
Oregon:											
Portland	4	5	2	3	0	2	1	2	0	0	72
Salem	0	0	1	0	0	0	1	0	0	0	----
California:											
Los Angeles	12	21	0	0	0	18	3	4	0	17	216
Sacramento	2	1	0	0	0	4	1	1	0	0	24
San Francisco	8	5	0	0	0	13	1	1	0	9	157

City reports for week ended October 3, 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									
Maine:									
Portland	0	0	0	0	0	0	0	5	0
New Hampshire:									
Concord	0	0	0	0	0	0	0	1	0
Massachusetts:									
Boston	1	1	0	0	0	0	4	31	4
Fall River	0	0	0	0	0	0	0	2	0
Springfield	0	0	0	0	0	0	0	10	3
Worcester	0	0	0	0	0	0	0	3	1
Rhode Island:									
Providence	2	1	0	0	0	0	0	4	0
Connecticut:									
Bridgeport	0	0	0	0	0	0	0	12	1
Hartford	0	0	0	0	0	0	1	6	0
New Haven	0	0	0	0	0	0	0	7	0
MIDDLE ATLANTIC									
New York:									
New York	4	2	0	0	0	0	15	140	10
Rochester	0	0	0	0	0	0	1	2	0
Syracuse	0	0	0	0	0	0	1	1	0
New Jersey:									
Newark	0	0	0	0	0	0	1	7	0
Pennsylvania:									
Philadelphia	0	0	0	0	0	0	1	8	0
Pittsburgh	1	1	0	0	0	0	0	0	0
EAST NORTH CENTRAL									
Ohio:									
Toledo	0	0	0	0	0	0	0	1	1
Indiana:									
Fort Wayne	0	0	0	0	0	0	0	2	0
Illinois[1]									
Chicago	3	2	1	0	0	0	4	13	1
Michigan:									
Detroit	0	0	0	0	0	0	4	9	0
Flint	0	0	0	0	0	0	0	2	0
Grand Rapids	0	0	0	0	0	0	1	1	0
Wisconsin:									
Kenosha	0	0	0	0	0	0	0	2	0
Madison	1	0	0	0	0	0	0	4	0
Milwaukee	0	0	0	0	0	0	0	2	2
Racine	0	0	0	0	0	0	0	3	0
Superior	0	0	0	0	0	0	0	4	0
WEST NORTH CENTRAL									
Minnesota:									
Duluth	0	0	0	0	0	0	0	2	0
Minneapolis	0	0	0	0	0	0	2	12	0
St. Paul	0	0	0	0	0	0	0	20	0
Missouri:									
St. Louis	1	0	1	0	0	0	0	2	1
North Dakota:									
Fargo	0	0	0	0	0	0	0	1	0

[1] Typhus fever, 3 cases: 1 case at Springfield, Ill., and 2 cases at Savannah, Ga.

City reports for week ended October 3, 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
SOUTH ATLANTIC									
Maryland:									
Baltimore	0	0	1	0	0	0	1	1	1
District of Columbia:									
Washington	0	0	0	0	0	0	1	4	0
Virginia:									
Richmond	0	0	0	1	0	0	1	0	0
West Virginia:									
Charleston	2	1	0	0	0	0	0	0	0
North Carolina:									
Raleigh	0	0	0	0	1	0	0	0	0
Winston-Salem	0	0	0	0	1	1	0	0	0
South Carolina:									
Charleston	0	0	1	0	0	0	0	0	0
Columbia	0	0	0	0	0	1	0	0	0
Georgia:									
Savannah [1]	0	0	0	0	1	0	0	0	0
EAST SOUTH CENTRAL									
Tennessee:									
Memphis	0	0	0	0	0	0	1	2	0
Nashville	0	1	0	0	0	0	1	0	0
Alabama:									
Birmingham	1	1	0	0	0	0	0	0	0
WEST SOUTH CENTRAL									
Arkansas:									
Little Rock	0	0	0	0	0	1	0	0	0
Louisiana:									
New Orleans	1	0	0	0	0	0	0	0	0
Texas:									
Dallas	0	0	0	0	2	2	0	0	0
Fort Worth	0	0	0	0	0	1	0	0	0
Galveston	0	0	0	0	0	1	0	0	0
MOUNTAIN									
New Mexico:									
Albuquerque	0	0	0	0	0	0	0	1	0
PACIFIC									
Washington:									
Seattle	1	0	0	0	0	0	1	0	0
Tacoma	1	0	0	0	0	0	1	1	0
California:									
Los Angeles	1	0	0	0	0	0	2	0	0
San Francisco	1	1	1	1	1	0	1	1	0

[1] Typhus fever, 3 cases: 1 case at Springfield, Ill., and 2 cases at Savannah, Ga.

The following tables give the rates per 100,000 population for 98 cities for the 5-week period ended October 3, 1931, compared with those for a like period ended October 4, 1930. The population figures used in computing the rates are estimated mid-year populations for 1930 and 1931, respectively, derived from the 1930 census. The 98 cities reporting cases have an estimated aggregate population of more than 33,000,000. The 91 cities reporting deaths have more than 31,500,000 estimated population.

Summary of weekly reports from cities, August 30 to October 3, 1931.—Annual rates per 100,000 population compared with rates for the corresponding period of 1930 [1]

DIPHTHERIA CASE RATES

	Week ended—									
	Sept. 5, 1931	Sept. 6, 1930	Sept. 12, 1931	Sept. 13, 1930	Sept. 19, 1931	Sept. 20, 1930	Sept. 26, 1931	Sept. 27, 1930	Oct. 3, 1931	Oct. 4, 1930
98 cities	36	40	35	44	34	46	45	56	[2] 56	60
New England	55	39	58	60	36	34	38	56	50	53
Middle Atlantic	24	29	26	26	22	36	25	31	25	40
East North Central	38	48	32	63	29	74	42	74	44	79
West North Central	23	35	34	56	42	48	71	58	[3] 88	60
South Atlantic	34	66	45	68	73	46	67	100	150	68
East South Central	81	48	99	24	93	24	128	30	140	102
West South Central	105	56	41	45	57	63	101	136	108	104
Mountain	52	44	26	35	17	26	52	62	78	9
Pacific	27	32	29	22	29	12	41	26	[4] 43	51

MEASLES CASE RATES

98 cities	19	24	14	16	22	16	15	18	[2] 18	19
New England	58	36	29	41	31	19	31	46	24	36
Middle Atlantic	14	27	8	19	18	16	9	13	12	12
East North Central	11	12	13	9	17	14	16	13	12	5
West North Central	8	31	11	15	13	19	4	29	[3] 10	70
South Atlantic	8	28	6	6	14	22	8	10	2	22
East South Central	6	24	6	6	0	0	0	66	29	0
West South Central	10	0	10	3	17	0	3	10	17	7
Mountain	52	53	35	35	122	44	44	26	35	70
Pacific	67	34	45	16	53	18	51	16	[4] 82	22

SCARLET FEVER CASE RATES

98 cities	48	42	49	50	57	61	57	71	[2] 66	71
New England	87	60	106	56	87	77	53	87	132	80
Middle Atlantic	37	24	30	26	43	45	45	32	51	46
East North Central	56	47	64	84	62	90	62	117	62	106
West North Central	27	58	36	35	59	45	65	77	[3] 95	72
South Atlantic	51	72	55	56	71	44	67	62	59	76
East South Central	87	60	64	36	81	36	93	114	70	66
West South Central	54	63	41	24	47	52	34	52	37	35
Mountain	26	35	61	79	87	70	122	97	96	115
Pacific	43	28	39	63	55	67	71	75	[4] 74	73

SMALLPOX CASE RATES

98 cities	1	3	1	3	1	4	0	3	[2] 0	1
New England	0	0	2	0	0	0	0	0	0	0
Middle Atlantic	0	0	0	0	0	0	0	0	0	0
East North Central	4	2	2	2	1	9	0	2	0	1
West North Central	4	14	6	27	0	21	6	14	[3] 2	0
South Atlantic	0	4	0	0	0	0	0	0	0	2
East South Central	0	0	6	0	0	0	0	0	0	0
West South Central	0	0	0	0	0	0	0	3	0	3
Mountain	0	0	0	0	0	0	0	0	0	0
Pacific	2	12	0	8	4	4	0	16	[4] 0	0

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

Summary of weekly reports from cities, August 30 to October 3, 1931.—Annual rates per 100,000 population compared with rates for the corresponding period of 1930—Continued

TYPHOID FEVER CASE RATES

	Week ended—									
	Sept. 5, 1931	Sept. 6, 1930	Sept. 12, 1931	Sept. 13, 1930	Sept. 19, 1931	Sept. 20, 1930	Sept. 26, 1931	Sept. 27, 1930	Oct. 3, 1931	Oct. 4, 1930
98 cities	20	21	23	26	42	22	21	17	[2]21	20
New England	7	12	7	22	22	12	5	12	17	12
Middle Atlantic	13	20	13	24	16	15	16	13	21	14
East North Central	16	12	10	17	91	11	15	9	9	9
West North Central	6	14	13	21	38	29	36	15	[3]14	14
South Atlantic	49	58	79	70	26	68	43	56	65	42
East South Central	41	48	35	48	47	48	47	18	52	60
West South Central	74	45	91	52	44	63	47	35	24	52
Mountain	44	9	35	62	26	0	26	44	26	115
Pacific	10	8	27	4	35	14	10	12	[4]14	16

INFLUENZA DEATH RATES

91 cities	2	3	4	3	3	3	2	2	3	2
New England	2	0	2	0	2	2	0	2	2	0
Middle Atlantic	1	3	4	4	3	2	1	2	3	1
East North Central	1	2	3	3	3	2	3	2	2	0
West North Central	3	6	9	0	6	0	0	0	12	2
South Atlantic	2	8	2	2	4	0	4	4	0	2
East South Central	6	0	0	19	0	26	6	13	6	13
West South Central	10	11	17	0	0	7	0	4	0	11
Mountain	0	9	0	0	0	18	0	0	0	18
Pacific	2	0	2	0	2	0	0	5	0	2

PNEUMONIA DEATH RATES

91 cities	50	53	55	54	60	57	52	57	53	58
New England	24	56	58	68	50	56	67	39	58	44
Middle Atlantic	62	65	65	63	66	65	55	72	60	59
East North Central	33	36	36	43	45	42	38	47	35	53
West North Central	62	51	44	45	44	75	44	36	59	60
South Atlantic	61	68	63	58	57	56	51	56	61	52
East South Central	38	91	82	26	57	71	32	65	63	104
West South Central	83	50	73	57	93	46	52	71	66	71
Mountain	96	53	70	123	78	115	70	53	61	152
Pacific	19	27	46	25	84	40	86	40	53	40

[2] Waterloo, Iowa, and Spokane, Wash., not included.
[3] Waterloo, Iowa, not included.
[4] Spokane, Wash., not included.

FOREIGN AND INSULAR

CANADA

Quebec Province—Communicable diseases—Week ended September 26, 1931.—The Bureau of Health of the Province of Quebec, Canada, reports cases of certain communicable diseases for the week ended September 26, 1931, as follows:

Disease	Cases	Disease	Cases
Chicken pox	36	Poliomyelitis	105
Diphtheria	47	Scarlet fever	47
Erysipelas	2	Tuberculosis	39
German measles	3	Typhoid fever	23
Measles	16	Whooping cough	24
Mumps	11		

CHINA

Shansi Province—Vital statistics—Year 1923.—According to the Nankai Weekly Statistical Service for July 13, 1931, published by the Institute of Economics of Nankai University at Tientsin, deaths from certain diseases occurred in the Province of Shansi during 1923 as shown in the table below. Evidently 1923 is the latest year for which such statistics for the Province have been published. The population in 1923 was given as 11,799,109.

Disease	Number of deaths	Death rate per 100,000 population	Disease	Number of deaths	Death rate per 100,000 population
Cholera	2,732	23.2	Measles	21,625	183.3
Diphtheria	6,647	65.3	Smallpox	8,203	69.5
Dysentery	7,691	64.4	Tuberculosis	15,108	128.1
Malaria	834	7.1			

The following table shows the number of births and deaths, the birth and death rates per 1,000 population, and the rate of natural increase in Shansi Province for the years 1912 to 1923:

Year	Births		Deaths		Natural increase rate
	Number	Rate per 1,000 population	Number	Rate per 1,000 population	
1912	343,015	34.0	218,333	21.7	12.3
1913	327,676	32.0	193,791	18.9	13.1
1914	348,648	33.4	142,573	13.6	19.8
1915	448,173	43.3	246,534	23.8	19.5
1916	639,988	60.8	421,876	40.1	20.7
1917	703,213	62.5	245,503	21.7	40.8
1918	566,153	55.7	242,813	23.9	31.8
1919	145,902	12.3	167,374	14.1	−1.8
1920	153,035	13.4	132,090	11.5	1.9
1921	150,410	12.9	134,977	11.6	1.3
1922	176,634	15.1	160,908	13.7	1.4
1923	180,369	15.3	136,709	11.6	3.7

CUBA

Provinces—Communicable diseases—Four weeks ended August 29, 1931.—During the four weeks ended August 29, 1931, cases of certain communicable diseases were reported in the Provinces of Cuba, as follows:

Disease	Pinar del Rio	Habana	Matanzas	Santa Clara	Camaguey	Oriente	Total
Chicken pox		2	2			47	51
Diphtheria		5	1	3	4	3	16
Malaria		6		2	4	34	46
Measles		52	4	14			70
Paratyphoid fever		4	1	1		1	7
Scarlet fever		2	1	1			4
Typhoid fever	3	23	10	47	9	29	121

DENMARK

Communicable diseases—August, 1931.—During the month of August, 1931, cases of certain communicable diseases were reported in Denmark as follows:

Disease	Cases	Disease	Cases
Anthrax	2	Mumps	89
Cerebrospinal meningitis	5	Paratyphoid fever	31
Chicken pox	13	Poliomyelitis	5
Diphtheria and croup	217	Scabies	601
Erysipelas	232	Scarlet fever	210
German measles	2	Syphilis	106
Gonorrhea	966	Tetanus	1
Influenza	2,952	Typhoid fever	8
Lethargic encephalitis	3	Undulant fever (*Bacillus abortus*, Bang)	51
Measles	799	Whooping cough	1,496

PANAMA CANAL ZONE

Communicable diseases—August, 1931.—During the month of August, 1931, certain communicable diseases, including imported cases, were reported in the Panama Canal Zone and terminal cities as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Chicken pox	3		Measles	44	1
Diphtheria	5		Mumps	1	
Dysentery, amebic	4		Pneumonia		9
Dysentery, bacillary		1	Tuberculosis		24
Leprosy	1		Typhoid fever	4	
Malaria	236		Whooping cough	16	

TASMANIA

Vital statistics—1930.—According to statistics published by the Commonwealth Bureau of Census and Statistics, at Hobart, Tasmania, births occurring during 1930 numbered 4,785 and deaths

1,948. There were 242 deaths of infants under 1 year of age, a rate of 50.6 per 1,000 births. The birth and death rates per 1,000 population in the urban and rural sections of Tasmania during the years 1920–1929, 1929, and 1930 are given in the accompanying table. The population of Tasmania in 1928 was approximately 215,000.

	1930	1929	1920–1929
Births per 1,000 population:			
Urban districts	19.3	19.6	22.7
Rural districts	24.4	24.6	26.2
Total	22.2	22.4	24.8
Deaths per 1,000 population:			
Urban districts	10.8	11.4	11.5
Rural districts	7.7	9.3	8.5
Total	9.0	10.2	9.8

Cases of certain communicable diseases occurred in Tasmania during 1930, as compared with 1928 and 1929, as follows:

Disease	1930	1929	1928
Diphtheria	572	488	909
Puerperal fever	27	25	21
Scarlet fever	486	314	189
Syphilis	26	34	29
Tuberculosis	203	177	208
Typhoid fever	27	49	53

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		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26	October, 1931 3	10
Ceylon: Colombo	C		1	1					1	1	1								
	D		1	1					1	1	1								
China:																			
Canton	C	1	2	1									1	1					
	D		1																
Shanghai	C					1				1	5	1	1	3	4	36			
Swatow	C			10	7														
Tientsin	C		1	10															
	D		1	1															
India	C	11,462	13,604	18,001	4,737	5,002	5,707	6,628	7,357	9,848	9,817	9,492							
	D	5,767	7,270	10,337	2,677	2,848	3,064	3,504	4,029	5,584	5,411	5,252							
Bombay	C	2				1	11	11	9	18	6	11	27	5	5	5			
	D	1					6	10	4	9	7	5	9	5	2	1			
Calcutta	C	310	265	292	72	62	55	48	42	27	20	21	10	3	15				
	D	176	149	168	35	34	58	28	10	7	7	6	4	2	3				
Karikal	C	19	12								1		1			1			
	D	14	7								1		1			1			
Madras	C	26	52	9	2	2			1		2	3	3	1	1				
	D	13	17	4															
Moulmein	C						1												
	D						1												
Negapatam	D												1						
Rangoon	C		2	4		1	2	1		1	1						1		
	D		1	2			1			1	1						1		
Vizagapatam	C			1															
India (French):																			
Chandernagor	C	6	4	3	1	1	1	2	1	4	2			1					
	D	5	4	3		1			1	4	2			1					
Pondicherry	C	24	17	3		1	1	1	1	1	1		2			2			
	D	4	7	3		1	1	1	1		1		1			1			

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

CHOLERA—Continued

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

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26	October, 1931 3	10
India (Portuguese)	C			1		2				1									
	D					1				1									
Indo-China (see also table below):																			
Cochin-China—Rachgia	C								P										
Pnompenh	C	2		1		1	4			1		1			1	1			
	D	1	2	1		1	1			1					1	1			
Saigon and Cholon	C	27	104	61	8	3	3												
	D	22	76	41	3	2	2												
Iraq:																			
Abulkhasib	C												6						
	D												5						
Amara	C											2	22	35	8	1			
	D											1	21	30	7	1			
Amara Province	C												6	11	106	73	32	21	
	D												5	4	67	44	29	24	
Basra	C								3	9	263	272	148		54	91	77	19	
	D								2	8	140	137	76		30	48	34	11	
Basra Province	C											5	14	6	10	23	26	14	
	D											2	10	3	7	10	9	8	
Dinwaniyah	C																1		
Dinwaniyah Province	C																15	8	
	D																11	6	
Iwaniyah	C																22		
	D																15		
Muntafiq Province	C												10	21	66	128	55	54	
	D												8	20	42	75	38	57	
Nasiriyah	C													22	50	16	4	4	
	D													15	40	20	3	4	
Suqelshuyukh	C												2						
	D												2						
Persia: Rafsanjan [1]	C		36																
	D		14																

Philippine Islands:[2] Provinces—																				
Capiz	C	29	17	4										9	9	17	49	21	5
	D	24	15	4										5	6	5	35	16	5
Cebu	C									1	1	1							
	D									1	1	1							
Iloilo	C			26	24	3													
	D			21	22	3													
Negros, Occidental	C			2															
	D			1															
Pampanga	C		1																
Siam	C	16	14	4	1	1		1				1	1						
	D	4	5	2		1							1						
Bangkok	C	3	3	1	1			3				1	1						
	D	2	1	1				2											
On vessel:																			
S. S. Arankola, at Rangoon from Calcutta	C		1																
S. S. City of Eastborne, at Calcutta from Cocanada	C			1															
S. S. Tairea, at Penang from Calcutta	C			1															
S. S. Bandar Shalpour, at Bushire, Persia, from Basra	C							1											
	D							1											
S. S. Kohistan, at Basra from Bushire, Persia	C							2											
S. S. Cathay, at Kobe, Japan, from Shanghai	C											4							
	D											1							
S. S. Kasagi Maru, at Moji from Shanghai	C													1					
S. S. Ankoo, at Nagasaki from Shanghai	C														2				
	D														1				

Place		February, 1931	March, 1931	April, 1931	May, 1931			June, 1931			July, 1931			Aug. 1-10, 1931
					1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	
Indo-China (French) (see also table above):														
Cambodia[3]	C	125	100	113	33	44	40	83	96	129	72	82	87	12
	D	80	29	70	20	22	21	45	64				60	2
Cochin-China[3]	C	29	105	107	47	52	75	71	69		66	30	47	39
	D	18	73	74	36	40	57	52	54				42	32

[1] From May 3 to 25, 1931, 152 cases of cholera with 75 deaths were reported in Rafsanjan and vicinity, Karman district, Persia.
[2] Figures for cholera in the Philippine Islands are subject to correction.
[3] Reports incomplete.

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

PLAGUE

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

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931				August, 1931					September, 1931				October, 1931	
					4	11	18	25	1	8	15	22	29	5	12	19	26	3	10
Algeria:																			
Algiers	C								2										
Bone	C			1															
Philippeville	C						1				1	1							
	D						1				1								
Argentina: San Juan Province	C						P	P											
Belgian Congo	C			1															
	D			1															
British East Africa (see also table below):																			
Tanganyika	C	18	46	17			6				8								
	D	21	30	10			6				2								
Uganda	C	35	138	298	95	132	98	93	71	93	69								
	D	32	126	286	94	129	96	90	71	93	68								
Ceylon: Colombo	C	4	3	2				1	4	1	1			1	1	1		1	1
	D	3	3	2				1	4	1	1			1	1	1		1	1
Plague-infected rats		1	5						1	3	4								
China: [1]																			
Amoy [1]	C		1																
	D		1																
Dutch East Indies:																			
Batavia and West Java	C	74	59	116	21	18	19	17	12	11	20	15	19						
	D	71	59	66	21	18	19	17	12	11	20	15	19						
East Java and Madura	C	1	1																
	D	1	1																
Java and Madura	D	243	176	192	59	55	52	66	38	53	67	47	58						
Egypt:																			
Alexandria	C			4	1	1	2	9	4	3	1	1	2	2		1	1		
	D			4	1			4	1	2			1	1					
Assiout	C	32	18	11															
	D	17	7	1															
Beni-Suef	C	12	5																
	D	3	3																
Beheira	C								1		1			2					
Dakahlia	C						1			2									
Deirout	C	3	10	3															
	D	1	4	1															
Gharbieh	C			1															
	D			1															
Girga	C	44	7		1														
	D	22	2																

Kona	C	3	1																
	D	1	1																
Minieh	C	1	6	3	10		2												
	D		3	1	2		1	1											
Port Said	C			3	1	1	2	1	2										
	D		1	2	1														
Tanta	C										2			1		1			
Hawaii Territory:																			
Hawaii—Hamakua—Plague-infected rats			1								1								
Maui Island—																			
Haliimaile—Plague-infected rats																1			
Kula District	C									1									
	D									1									
Makawao—Plague-infected rats																1			
India	C	6,142	752	88	30	29	78	84	164	175	130	215							
	D	5,199	692	51	15	13	42	58	94	117	92	137							
Bassein	C	1	1		1			3		1		1		1	2	1	1		
	D	1	1		1			2		1		1		1	2	1	1		
Bombay	C	11	8		1	1	11												
	D	11	6				6												
Plague-infected rats		137	94	37	11	16	9	12	8	13	17	9	23	17	7	10	9		
Burma	C						7	9											
	D						5	5											
Calcutta	C	2																	
	D	2																	
Madras Presidency	C	3	2	6	1	2	8	10					9	6	39				
	D	2	1	1		1	1	7					4	5	20				
Moulmein	C					1	1	7					P	5					
	D						1							4	3	2	2		
Rangoon	C	1	2	1			2		1				2	1					
	D	1	2	1			1		1				1	1					
Plague-infected rats		4	7	3	1	2	2	1	1		1	1	1	1	1	1	1		
Indo-China (see also table below): Pnompenh	C			3															
	D	4		2															
Iraq:																			
Baghdad	C	23	23	23	1	1	1				1			2	1				
	D	8	9	9	1		1							1					
Maudhan	C		2																
Madagascar (see also table below): Tamatave	C								1						2				
Morocco	C																10		
Nigeria: Lagos	C	5																	
	D	5																	
Plague-infected rats		6																	
Peru (see table below).																			
Senegal (see table below).																			
Siam	C	1	2	1														1	
	D	1	2	1														1	
Spain: Hospitalet—Barcelona Province	C											5	1			1	1	1	
	D											2				1			
Syria: Beirut	C					1		1			1				1			2	

[1] On July 27, 1931, 1,250 cases of plague were reported in Chiobe and Changchow, China, since April; and on September 19, 1931, 18 deaths were reported in Changchuanper and new cases in Kaitung and Fengtien.

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

PLAGUE—Continued

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

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931				August, 1931					September, 1931				October, 1931	
					4	11	18	25	1	8	15	22	29	5	12	19	26	3	10
Tunisia: Tunis	C	16	16	11	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	-----
	D	8	3	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Union of South Africa:																			
Cape Province	C	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	D	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Plague-infected rats		-----	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----
Orange Free State	C	2	2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	D	2	2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Place		April, 1931	May, 1931	June, 1931	July, 1931	August, 1931	September, 1931
British East Africa (see also table above):							
Kenya	C	345	245	154	484	197	-----
Indo-China (see also table above)	C	11	-----	2	1	-----	1
	D	2	-----	2	1	-----	-----
Madagascar (see also table above):							
Ambositra Province	C	30	19	15	1	-----	-----
	D	29	18	15	1	-----	-----
Antsirabe Province	C	48	7	12	13	-----	-----
	D	47	7	12	12	-----	-----
Miarinarivo Province	C	6	2	-----	8	-----	-----
	D	6	2	-----	7	-----	-----
Moramanga Province	C	-----	2	1	1	-----	-----
	D	-----	2	-----	-----	-----	-----
Tananarive Province	C	41	18	10	5	-----	-----
	D	40	18	9	5	-----	-----

Place		April, 1931	May, 1931	June, 1931	July, 1931	August, 1931	September, 1931
Peru	C	8	2	5	2	-----	-----
	D	1	-----	1	-----	-----	-----
Senegal:							
Baol [1]	C	-----	4	-----	27	101	13
	D	-----	3	-----	13	58	8
Dakar [1]	C	2	63	64	95	194	38
	D	1	49	56	73	106	24
Diourbel [1]	C	-----	-----	-----	-----	-----	9
	D	-----	-----	-----	-----	-----	3
Louga [1]	C	1	5	4	3	2	4
	D	-----	2	2	1	1	1
Rufisque [1]	C	-----	1	2	34	2	1
Thies [1]	C	-----	-----	12	16	26	12
	D	-----	-----	3	7	16	8
Tivaouane [1]	C	4	19	3	3	-----	-----
	D	-----	11	2	2	-----	-----

[1] Reports incomplete.

SMALLPOX

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26	Oct. 3, 1931
Algeria:																		
Algiers	C	2	1	8			1											
Constantine	C		1		1									1				
Belgian Congo	C		47	42														
Bolivia.[1]																		
Brazil: Porto Alegre (alastrim)	C	53	19	5	9	10	9	13	11	6	17		7	13				
	D					1			1				2					
British East Africa: Tanganyika	C		13	7	37	83		29	1	18								
	D				7	5		5										
British South Africa:																		
Northern Rhodesia	C					21												
Southern Rhodesia	C			1		2												
Canada:																		
Alberta	C						1			1								
British Columbia	C							2	2			3		1	1			
Manitoba	C			4												1		
Winnipeg	C														1			
Nova Scotia	C	1																
Ontario	C	9	17	32	14	3	6	12	1		2	2	4		2			
Kingston	C	5												1				
Ottawa	C			1											1		5	2
Sault Ste. Marie	C	4	1															
Toronto	C	4	1	1														
Quebec	C				1													
Saskatchewan	C	46	48	54		13	10	19		10	6	10	8	8	12	5		
Regina	C	2	2															
Chile:																		
Antofogasta	C				1													
Chanaral	C		1															
China:																		
Amoy	C	2	6	4	1	1			1						1			
	D	1	3	3	1	1			1						1			
Canton	C	4	3	1	1			1					1					
Foochow	C	P	P	P				P		P		P						
Hankow	C	3	5	4	1		2		1		1	1						
Hong Kong	C	3	1															
	D	1	2															

[1] An epidemic of smallpox was reported on May 18 with 716 cases and 314 deaths since the middle of April, 1931, in Mendez Province, Bolivia.

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

SMALLPOX—Continued

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

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26	Oct. 3, 1931
China—Continued																		
Manchuria—																		
Harbin (see also table below)	C		3															
Kwantung—Dairen	C	2	2	1														
Nanking	C	P	P															
Shanghai—																		
Foreigners only	C	17	7	11	2	1												
Including natives	D	18	7	13	2	1	2	1				1	1			1		
Swatow	D	2																
Tientsin	C		2			2	1											
Chosen (see table below).																		
Colombia:																		
Cali	D		1															
Santa Marta	D														1			
Dutch East Indies:																		
Batavia and West Java	C		2															
East Java and Madura	C		1															
Eritrea	C		3					2					10					
	D												2					
Finland	C	1																
France (see table below).																		
Great Britain:																		
England and Wales	C	744	570	287	56	45	50	36	26	25	19	21	33		19	45	45	
Bradford	C	6	8	5														
Leeds	C	2	2															
London	C	227	183	122	21	9	12	12	6	12	4	4	3	9	5	15	5	
London and Great Towns	C	558	403	228	53	33	34	32	22	20	17	10	13	30	11	34	35	
	D	2		1	1													
Sheffield	C	7													1	1		

Greece (see table below).																		
Honduras:																		
Tegucigalpa	C	1																
Tela	C	1																
India	C	14,265	11,403	7,313	1,492	1,376	1,236	1,255	978	904	645	400						
	D	2,923	1,849	1,704	404	363	292	293	234	213	179	120						
Bassein	C		1															
Bombay	C	8	9	6		1	3	2	1		1			1	2			
	D	5	4	5		1	3	2	1					1				
Calcutta	C	287	89	47	11	6	2	2	4	4		5	2	1	2		1	
	D	224	75	41	9	4	3	2		4		5	2	1	2		1	
Cochin	C	39	3							1	1	1					1	
Karachi	C	6		2					1									
	D			1														
Madras	C	19	8	2		2			1					1				1
	D	5	6	1														
Negapatam	C	3		3			1			2			3		1			
Rangoon	C	11	13	6	2		1		2		1	1	1		1			
	D	1	5	2	1				1			1			1			
Vizagapatam	C	10	6	6	2		2	1		3		2	3	1	1	1	2	
	D	2	1	2	1					3		1	3	1	1	1		
India (French):																		
Chandernagor	C	10	7	1	2		1											
	D	7	5		2													
Karikal	C	4	4	6	1	1	1	1	1	1	3	2		2				
	D	3	4	6	1	1	1	1	1	1	2	2		2				
Pondicherry Province	C	6	11	7	4	1		23	11			3	1	6	1			
	D	9	11	7	4	1		23	11			3	1	6	1			
India (Portuguese)	C	21	3															
	D	6	1															
Indo-China (see also table below):																		
Pnompenh	C		1	2														
	D		1															
Saigon and Cholon	C	1	2		1			2	1	1			1		3	2	1	
	D	1	1		1				1				1		2		1	
Iraq:																		
Baghdad	C	2	3	1											1			
	D		2															
Basra	C		2	1														
Mosul Liwa	C						1					1					5	
Ivory Coast (see table below).																		
Japan: Nagoya	C						1											
Mexico (see also table below):																		
Jalisco (State)—Guadalajara	D	1	2	1	1	1		1			2						1	
Mexico City and surrounding territory	C	43	45	25	12	5	4	1	8	2			2	2	1			
	D	14	11	13	4	3	1		1	1					1	1		
Monterrey	C			1														
Torreon	C	1	1	3										1	1			
	D	2		2											1			
Vera Cruz	O	2	1															

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

SMALLPOX—Continued

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

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26	Oct. 3, 1931
Morocco (see table below).																		
Poland	C		3	3		17		1								1		
Portugal: Lisbon	C	56	67	48	15	12	18		17	12	8		10	21	18	17		
Rumania (see table below).																		
Siam	C	1	6	5		1												
	D		1	1			1											
Spain	C						7											
Straits Settlements	C	10	2							1								
	D	5	2															
Sudan (Anglo-Egyptian)	C	3	6	1											32			
	D		2												6			
Sudan (French) (see table below).																		
Syria (see table below).																		
Turkey (see table below).																		
Union of Socialist Soviet Republics (see table below).																		
Union of South Africa:																		
Cape Province	C	P	P															
Natal	C											P			P			
Orange Free State	C	P	P	P	P	P	P				P	P	P					
Transvaal	C			P	P	P	P											
Upper Volta	C	3	88	12	1		1											
	D		1															
On vessel:																		
S. S. Clan McTavish at Manila from Chittagong	C	1																
S. S. Taif (pilgrim ship) at Saukin from Jeddah	C	1										1						
S. S. Talodi at Suakin	C		1															

Place		February, 1931	March, 1931	April, 1931	May, 1931			June, 1931			July, 1931			August, 1931		
					1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-31
Indo-China (see also table above)	C	168	264	142	-------	17	41	30	16	1	1	-------	7	29	-------	-------
	D	35	82	-------	-------	-------	-------	-------	-------	-------	1	-------	4	11	-------	-------
Ivory Coast	C	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	7
Sudan (French)	C	-------	4	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Syria: Beirut	C	-------	-------	-------	-------	-------	-------	-------	1	-------	-------	-------	-------	-------	-------	-------

Place		Jan., 1931	Feb., 1931	Mar., 1931	Apr., 1931	May, 1931	June, 1931	July, 1931
China: Harbin (see also table above)	C	-------	-------	7	-------	13	10	-------
Chosen	C	1	-------	11	-------	1	4	2
	D	1	-------	3	-------	-------	-------	1
France	C	4	16	15	6	54	9	20
Greece	C	-------	4	-------	-------	3	1	-------
Mexico (see also table above)	D	-------	3	-------	1	1	2	-------
Morocco	C	-------	4	6	7	49	48	23
Rumania	C	-------	-------	1	-------	1	-------	-------
Turkey	C	63	37	1	-------	9	1	-------
	D	7	6	-------	-------	-------	-------	-------
Union of Socialist Soviet Republics	C	-------	-------	-------	1,516	1,345	-------	-------
Territories in Asia	C	194	532	-------	-------	-------	-------	-------
Ukraine	C	44	23	-------	-------	-------	-------	-------
Other territories in Europe	C	896	1,577	-------	-------	-------	-------	-------
Railroads, etc	C	43	77	-------	-------	-------	-------	-------

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

TYPHUS FEVER

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

Place		Mar. 8–Apr. 4, 1931	Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26
Algeria:																		
Algiers	C	3	3	7	9			2										
Bone	C											1	1					
Constantine Department	C	3	9	22	26	2		1		3							.2	
Oran	C		1	2	2						1					1		
Australia, Western	C	1	1	1														
Bulgaria	C	9	30	16	30									1				
	D	2	3	4	6													
China:																		
Canton	C	1																
Manchuria—Harbin	C	3	8		16													
Shanghai	C							1	2			1						
Tientsin	C		2															
Chosen (see table below).																		
Colombia: Cali	D														1			
Czechoslovakia (see table below).																		
Egypt:																		
Alexandria	C		1		3												1	
Beheira Province	C		4															
	D		2															
Cairo	C													1				
Eritrea: Asmara	C	1																
Great Britain: Scotland—																		
Fife County	C			1														
Kircudbright County	C																	1
Greece (see table below).																		
Guatemala (see table below).																		
Iraq: Baghdad	C	2		2														
	D			2														
Irish Free State:																		
Cork County—																		
Schull	C						1											
Skibbereen	C				2	1												

Kerry County—																		
Dingle	C			1														
Listowel	C				1													
Kildare County—Naas	C																	1
Limerick County—																		
Glin	C															2		
Limerick	C					2				1								
Michelstown	C					1												
Mayo County—																		
Belmullet	C			1														
Castlebar	C												1					
Westport	C												1					
Japan	C				1													
Latvia (see table below).																		
Lithuania (see table below).																		
Mexico (see also table below):																		
Durango	D								1									
Mexico City, including municipalities in Federal District	C	216	170	75	46	28	9	7	9	7	6		5	5	1	2	2	
	D	84	56	33	19	4	3	2	3	5	3		2	1	1		2	
San Luis Potosi	C	5	3	2			1	3					1					
Torreon	C								1									
	D								1									
Morocco	C	7	13	42	101	37	20	24	21		2	1	5					
	D		1	4	6	4	4											
Palestine	C	5	5	4	5	2				3	3	1	4				4	
Panama Canal Zone—Balboa	C			2														
Paraguay: Asuncion	D	1																
Poland	C	287	538	298	97	9	17	13	14	10	4	10	7	6	2		2	2
	D	15	28	18	4	2	1	1	1	1		1						
Rumania	C	214	70	169	80	2	2	7		7	9	4	3		4			
	D	16	8	18	13	2	2	1			1		1					
Syria	C			4														
Tunisia:																		
Sbeitla, vicinity of	C	20	12															
	D	7																
Sfax	C	2																
Tunis	C	14	13	29	73	1			1					1				
	D			3	4													
Turkey (see table below).																		
Union of Socialist Soviet Republics (see table below).																		
Union of South Africa:																		
Cape Province	C	1	P	P	P	P	P	P	P		P	P	P	P				
Municipality of East London	C	P			1					1								
Natal	C	1	P	P	P			P	P		P							
Orange Free State	C	P	P	P	P	P	P	12	P									
Transvaal	C	P	P	P	P	P	P	P	P		P	P	P	P				
Yugoslavia (see table below).																		

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

TYPHUS FEVER—Continued

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

Place		Feb., 1931	Mar., 1931	Apr., 1931	May, 1931	June, 1931	July, 1931	August, 1931
Chosen: Seoul	C	124	3	4	------	6	1	------
	D	8	------	1	------	1	1	------
Czechoslovakia	C	26	------	5	11	2	------	------
Greece	C	17	8	22	6	9	2	13
	D	2	1	3	------	------	------	2
Guatemala	C	------	------	------	------	33	34	3
	D	------	------	------	------	15	5	------
Latvia	C	12	------	------	------	------	------	------
Lithuania	C	3	99	34	10	13	8	2
	D	1	3	5	------	2	------	------

Place		Feb., 1931	Mar., 1931	Apr., 1931	May, 1931	June, 1931	July, 1931	August, 1931
Mexico (see also table above)	D	83	------	------	------	------	------	------
Turkey	C	18	15	32	13	11	9	------
Union of Socialist Soviet Republics	C	------	------	1,513	1,324	------	------	------
Territories in Asia	C	260	------	------	------	------	------	------
Ukraine	C	419	------	------	------	------	------	------
Other territories in Europe	C	1,373	------	------	------	------	------	------
Railroads, etc	C	158	------	------	------	------	------	------
Yugoslavia	C	12	10	43	14	2	3	1
	D	------	1	5	------	------	------	------

YELLOW FEVER

Place		Apr. 5–May 2, 1931	May 3–30, 1931	May 31–June 27, 1931	Week ended— July, 1931 4	11	18	25	August, 1931 1	8	15	22	29	September, 1931 5	12	19	26
Brazil:																	
Alagoas State	C	------	------	------	------	------	------	------	------	------	1	------	------	------	------	------	------
	D	------	------	------	------	------	------	------	------	------	1	------	------	------	------	------	------
Ceara State	C	2	1	1	------	------	------	------	------	------	------	1	------	------	------	------	------
	D	2	1	------	------	------	------	------	------	------	1	------	------	------	------	------	------
Minas Geraes State	C	5	2	------	------	------	------	------	------	------	------	------	------	------	------	------	------
	D	2	1	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Rio de Janeiro State	C	------	2	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Sergipe State	C	------	------	1	------	------	------	------	------	------	------	------	------	------	------	------	------
British Cameroons: Mamfe	C	------	3	2	------	------	------	------	------	------	------	------	------	------	------	------	------
	D	------	2	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Colombia—Magdalena Province—Near Cienaga	C	------	------	------	------	------	4	------	------	------	------	------	------	------	------	------	------

Gold Coast:																	
Akuse	C				2												
	D				1												
Dagomba District	C								2								
Kintampo	C						1										
	D						1										
Oda	C															1	
	D															1	
Tamale	C					2											2
	D					2											2
Wale Wale	C								1								
	D								1								
Ivory Coast:																	
Bobo Dioulasso	C					1											
	D					1											
Grand Bassam	C								4							1	
	D								2							1	
Kong Circle	C						4										
Seguela	C											P					
Nigeria: Abakaliki	C										1						
	D										1						
Senegal:																	
Podor (Hinterland)	C											1					
	D											1					
Saint Louis	C																1
Thies	C																1
	D																1
Sudan (French)	C						4	P									
Togo: Seva	C															1	
Upper Volta:																	
Banfora	C							2									2
	D							1									1
Diarabakoko	C																2
	D																1
Ouagadougou	C											1					1