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FURTHER STUDIES ON THE PRODUCTION OF DIBENZANTHRACENE TUMORS IN PURE STRAIN AND STOCK MICE

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In a previous communication (*1*) it was shown that subcutaneous injections of a 1:2:5:6-dibenzanthracene-lard solution induced sarcomas in pure strain mice and that the induced tumors were similar to spontaneous tumors arising in pure strain mice in that they grew only in animals of the same strain in which they originated. This report deals with the results of 3 more experiments concerning the response of both pure strain and stock mice to injections of a 1:2:5:6-dibenzanthracene-lard solution.

EXPERIMENTAL ANIMALS

Only adult male and virgin female mice weighing at least 20 grams were used.

All pure strain mice were obtained from the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine. The various strains employed are described as follows:

Strain A.—Inbred since 1918. Albino mice with a high incidence of spontaneous tumors in breeding females.

Strain C_3H.—Inbred since 1921. Color of wild house mice. The breeding females have a high incidence of mammary carcinomas.

Strain CBA.—Inbred since 1921. Color of wild house mice. These mice show a low incidence of spontaneous tumors.

Strain D.—Inbred since 1909. Dilute brown color. The breeding females show a high incidence of spontaneous tumor.

Stock mice.—Albino mice purchased from a local dealer and not pure strain animals.

TECHNIQUE

The dibenzanthracene-lard solution was prepared as follows: The lard was filtered at 38°C. and dibenzanthracene was then added in the proportion of 4 mg to each cubic centimeter of lard. The dibenzanthracene was dissolved by heating the lard to 140°C. The

resulting solution was kept at +4°C. until used, when it was heated to 40°C.

All injections were made subcutaneously in the right axillary region by means of an 18- or 20-gage needle and a 1-cc syringe.

Experiment 1

The purpose of this experiment was two-fold: First, to determine the relative susceptibility of various strains of mice to the carcinogenic action of dibenzanthracene; second, to ascertain whether repeated injections of the dibenzanthracene-lard solution would produce more tumors than a single injection. In a previous experiment (*1*) the mice had received 3 subcutaneous injections; but since the first tumor appeared only 15 days after the last injection, the necessity for the final injection was not established. Accordingly, the mice were divided into 3 groups, designated as groups A, B, and C in the following table, which shows the time of injections and the amounts given:

Date of injection	Amount	Group
	cc	
Feb. 15, 1934	0.2	A, B, and C.
Mar. 1, 1934	.2	B and C.
Mar. 8, 1934	.2	C.

The first tumors were noted on May 22, 1934, just 96 days after the first injection. The mice were examined each week up to September 7, 1934, when the experiment was discontinued. Mice dying during the course of the experiment and all mice living at the conclusion of the experiment were autopsied and examined macroscopically for the presence of tumor. The results of the experiment are presented in table 1. It is seen that many mice of both the D and C_3H strains died after receiving 3 injections of the dibenzanthracene-lard solution. However, the response of all 3 groups of stock mice and those of strains D and C_3H that had received 1 and 2 injections indicate that a single injection produced fewer tumors than did the repeated injections.

TABLE 1.—*Experiment 1: Results of injection of dibenzanthracene-lard solution*

Strain	Number of injections	Number of mice injected	Died from other causes	Number of mice developing tumor	Percent	Number living on Sept. 7, 1934
Stock	1	42	1	14	33	27
Do	2	43	9	17	40	17
Do	3	55	6	29	53	20
D	1	29	11	10	34	8
Do	2	30	2	15	50	13
Do	3	54	17	27	50	10
C_3H	1	32	6	24	75	2
Do	2	33	5	28	85	0
Do	3	30	15	15	50	0

It is also of interest to note that a single injection of the solution containing but 0.8 mg of 1:2:5:6-dibenzanthracene elicited tumors in a considerable number of mice. In fact, 75 percent of the C_3H mice developed tumors following the injection of this small quantity of dibenzanthracene. Such results indicate that a much smaller quantity of dibenzanthracene should be capable of inducing tumor growth.

The C_3H strain mice appear to be very susceptible to the carcinogenic action of dibenzanthracene. This fact is emphasized further in table 2, in which the time of appearance of the tumors is presented. By the end of the eighteenth week, 53 percent of the C_3H strain animals, 7 percent of the D strain mice, and only 1 percent of the stock mice had developed tumors.

TABLE 2.—*Experiment 1: Time in weeks of the appearance of dibenzanthracene-lard tumors*

Time in weeks		13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total number of tumors
Strain	Number of injections	Numbers of tumors observed																
Stock	1	----	----	----	----	----	----	1	1	----	1	----	1	3	2	2	3	14
Do	2	----	----	----	----	----	----	----	1	2	----	4	1	5	2	1	1	17
Do	3	----	----	1	----	----	1	1	4	4	----	2	4	4	3	3	2	29
D	1	----	----	----	----	----	----	1	1	----	----	2	2	----	----	1	3	10
Do	2	----	----	1	----	2	2	2	2	2	1	2	----	----	1	----	----	15
Do	3	2	----	----	----	1	----	2	2	3	3	3	3	----	3	1	4	27
C_3H	1	4	3	2	2	1	2	4	2	2	2	----	----	----	----	----	----	24
Do	2	3	10	3	4	1	4	1	1	----	----	1	----	----	----	----	----	28
Do	3	2	2	5	----	----	3	1	1	1	----	----	----	----	----	----	----	15

Experiment 2

In this experiment, animals of strains C_3H, A, and CBA received two injections of the dibenzanthracene-lard solution. Each injection consisted of 0.2 cc of the solution. The first was made on June 6, 1934, and the last on June 13, 1934. Every mouse was autopsied and examined for tumor in the internal organs. The first tumor appeared September 5, 1934, 91 days after the initial injection. The last living mouse developed a tumor on January 9, 1935. The results are of interest because, during the course of the experiment, only three mice died from causes other than tumor. The findings are presented in tables 3 and 4. Table 3 shows the high degree of susceptibility of all three strains to the carcinogenic action of 1:2:5:6-dibenzanthracene. Table 4 confirms and extends the findings in experiment 1 as regards the earlier appearance of tumors in the C_3H strain mice. At the end of the eighteenth week, 80 percent of the C_3H mice, 25 percent of the A mice, and none of the CBA animals had developed tumors. It is also of interest to note that tumors began to appear in the CBA strain just as a tumor developed in the last of the C_3H mice.

TABLE 3.—*Experiment 2: Results of injection of dibenzanthracene-lard solution*

Strain	Number of mice injected	Died from other causes	Number of mice developing tumor	Percent
C_3H	15	0	15	100
A	24	1	23	96
CBA	19	2	17	89

TABLE 4.—*Experiment 2: Time in weeks of the appearance of dibenzanthracene-lard tumors*

Time in weeks	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total number of tumors
Strain	Numbers of tumors observed																
C_3H	1		1	2	4	4	2	1									15
A		1	1	1	2	1		2	3	4	2			3	1	2	23
CBA								2	3	3	4			1	4		17

HISTOLOGICAL FINDINGS

When examined microscopically, practically all the tumors arising at the site of injection were found to be spindle-cell sarcomas. However, as in a previous experiment (*1*), a few were of the mixed type containing many round or giant cells. Active invasion of voluntary muscle was seen in every section.

Transplantation of tumors arising in pure strain mice into other mice of the same strain was easily accomplished.

LUNG TUMORS

In the earlier report (*1*) brief reference was made to the presence of lung tumors in mice receiving dibenzanthracene-lard injections. Throughout both experiments 1 and 2, all mice dying or killed were examined for macroscopic evidence of tumor in the lungs and other organs. A considerable number of lung tumors were found in the stock animals of experiment 1. Referring back to table 1, it is seen that 64 of the stock mice were alive on September 7, 1934, when the experiment was concluded. All these animals were killed and examined carefully for any evidence of tumor at the site of injection as well as in the internal organs. It was found that 33 of these animals had lung tumors, although all were free from tumor at the site of the dibenzanthracene-lard injections. The findings, as regards lung tumors in experiment 1, are summarized in table 5. The C_3H mice are omitted from the table, since all were free from lung tumors according to macroscopic examination. It is seen that about 45 percent of the stock mice had tumors in their lungs.

The presence of lung growths in the mice of experiment 2 is shown in table 6. In this experiment, the mice of only strain A showed

TABLE 5.—*Experiment 1: Summary of lung tumor findings*

Strain	Number of injections	Number of mice injected	Number of mice developing both lung and subcutaneous tumors	Number of mice developing lung tumors only	Total number of lung tumors	Percent
Stock	1	42	9	10	19	45
Do	2	43	9	10	19	44
Do	3	55	12	13	25	45
D	1	29	1	0	1	3
Do	3	54	1	0	1	2

any evidence of lung tumors. It was impossible to obtain data on the presence of lung tumors alone in this experiment, since all the strain A mice had tumors at the site of injection.

TABLE 6.—*Experiment 2: Summary of lung tumor findings*

Strain	Number of mice injected	Number of mice developing lung tumors	Percent
A	24	16	66
C_3H	15	0	0
CBA	19	0	0

Experiment 3

The presence of lung tumors in stock mice was confirmed in this experiment. The original purpose of the experiment was to ascertain the influence of a local irritant upon the development of dibenzanthracene tumors. With this end in view, one-half the mice received injections of the dibenzanthracene-lard solution, and the other half the same solution plus a trace of kaolin mixed with the injected material. The mice received 3 injections of 0.2 cc each; the first on February 16, 1934, the second on March 1, 1934, and the last on March 8, 1934. The first tumor appeared on June 13, 1934. The mice were examined each week up to September 7, 1934. At that time all the survivors were killed and examined macroscopically for tumor growth at both the site of injection and in the internal organs.

It was found that the presence of the irritant had no influence on the number or time of appearance of the tumors. Hence, the experiment is reported as furnishing additional evidence that the stock mice responded to subcutaneous injections of dibenzanthracene-lard solution by the production of lung tumors. The results are presented in table 7. Here, again, a considerable number of mice (24 percent) had lung tumors without any macroscopic evidence of tumor at the site of injection.

TABLE 7.—*Experiment 3: Summary of subcutaneous and lung tumors in mice following dibenzanthracene-lard injections*

Strain	Number of mice injected	Number of mice developing subcutaneous tumors	Number of mice developing both lung and subcutaneous tumors	Number of mice developing lung tumors only	Total number of lung tumors	Percent of lung tumors
Stock	53	21	8	13	21	40

SUMMARY

The results of the experiments again confirm the findings of Burrows, Hieger, and Kennaway (*2*) in showing that the subcutaneous injection of dibenzanthracene-lard solution induces sarcomas in mice.

They also confirm the previous findings made in this laboratory in showing that the solution induces tumors in pure-strain mice and that the induced tumors grow in members of the strain in which they originated.

In addition it has been shown that a single injection of dibenzanthracene solution containing 0.8 mg of dibenzanthracene produces tumors in all the strains of animals employed. However, the results of experiment 1 indicate that repeated injections produce a higher percentage of tumors.

The results obtained in experiment 2 demonstrate the extreme susceptibility of pure-strain mice of strains A, C_3H, and CBA to the carcinogenic action of dibenzanthracene. The findings as regards strain CBA are more striking when it is recalled that these mice, under normal conditions, develop very few spontaneous tumors.

It has also been shown that the strain C_3H mice respond to the dibenzanthracene injections by growing tumors earlier than any of the other strains used in these experiments. The reason for the earlier appearance of tumors in C_3H mice is not clear. The strain shows a high incidence of spontaneous tumors in breeding females, but in this laboratory the spontaneous tumor rate among the mice of strain C_3H is no higher than that of strain A mice. It would be of interest to ascertain whether the C_3H mice respond earlier to the action of other carcinogenic agents.

The results presented in tables 2 and 4 indicate that those animals belonging to strains possessing a tendency to the development of spontaneous tumors (strains A, C_3H, and D) react earlier to the carcinogenic activity of dibenzanthracene than do the ordinary stock mice or mice of strain CBA, both of which develop very few spontaneous growths.

The presence of lung tumors in mice following the subcutaneous injection of dibenzanthracene-lard solution cannot be explained at

this time. Practically all the lung tumors appeared in strain A or stock mice. The only common factor of these mice is their albino coat color. The mice of strain A are of pure stock and show a tendency toward the development of spontaneous tumors, but the ordinary stock mice used in this laboratory rarely develop spontaneous growths. While it is known that mice of strain A do possess a tendency toward the development of lung tumors, routine autopsies of these animals reveal very few such growths. No instance of lung tumor has been found in 100 routine autopsies of the stock mice.

Microscopic examination of lung growths showed that practically all were carcinomas, regardless of whether the mouse had a subcutaneous sarcoma or no tumor at the site of the dibenzanthracene-lard injection. Thus, it may be assumed that the lung growths are primary tumors. The problem concerning lung tumors is receiving further consideration.

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(1) Andervont, H. B.: Pub. Health Rep., **49**, 620 (1934).

(2) Burrows, H., Hieger, I., and Kennaway, E. L.: Am. Jour. Cancer, **16**, 57 (1932).

ACUTE RESPONSE OF GUINEA PIGS TO VAPORS OF SOME NEW COMMERCIAL ORGANIC COMPOUNDS

VIII. BUTANONE[1]

By F. A. Patty,[2] H. H. Schrenk,[3] and W. P. Yant[4]

This report on the acute response of guinea pigs to butanone (methyl ethyl ketone) vapor is the eighth of a series of similar reports[5] which deal with studies pertinent to establishing a criterion of the

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[5] Acute response of guinea pigs to vapors of some new commercial organic compounds:

I. Ethylene dichloride. Sayers, R. R., Yant, W. P., Waite, C. P., and Patty, F. A. Pub. Health Rep., vol. 45, no. 5, Jan. 31, 1930, pp. 225–239. (Reprint No. 1349.)

II. Ethyl benzene. Yant, W. P., Schrenk, H. H., Waite, C. P., and Patty, F. A. Pub. Health Rep., vol. 45, no. 22, May 30, 1930, pp. 1241–1250. (Reprint No. 1379.)

III. Cellosolve. Waite, C. P., Patty, F. A., and Yant, W. P. Pub. Health Rep., vol. 45, no. 26, June 27, 1930, pp. 1459–1466. (Reprint No. 1389.)

IV. Ethylene oxide. Waite, C. P., Patty, F. A., and Yant, W. P. Pub. Health Rep., vol. 45, no. 32, Aug. 8, 1930, pp. 1832–1843. (Reprint No. 1401.)

V. Vinyl chloride. Patty, F. A., Yant, W. P., and Waite, C. P. Pub. Health Rep., vol. 45, no. 34, Aug. 22, 1930, pp. 1963–1971. (Reprint No. 1405.)

VI. Dioxan. Yant, W. P., Schrenk, H. H., Waite, C. P., and Patty, F. A. Pub. Health Rep., vol. 45, no. 35, Aug. 29, 1930, pp. 2023–2032. (Reprint No. 1407.)

VII. Dichloroethyl ether. Schrenk, H. H., Patty, F. A., and Yant, W. P. Pub. Health Rep., vol. 48, no. 46, Nov. 17, 1933, pp. 1389–1398. (Reprint No. 1602.)

toxicity of some chemical products which have recently become commercially available for industrial application.

This investigation was undertaken at the request of Stanco, Inc., and was conducted jointly with the United States Bureau of Mines. The experiments were conducted at the Pittsburgh Experiment Station of the Bureau of Mines.

SCOPE OF WORK

The scope of the work included a study of the toxicity of, and the physiological response of guinea pigs exposed to, vapors of butanone (methyl ethyl ketone). Only acute effects as produced by a single exposure were studied. The experiments were planned to cover a range of concentrations which would produce slight or no response, moderate response, and serious response.

CHEMICAL AND PHYSICAL PROPERTIES

The butanone used in this study was a commercial grade of methyl ethyl ketone sold for industrial use. It was water clear and had an odor resembling that of acetone. An examination of the material gave the following physical properties:

Specific gravity

15.6°/15.6° C.... 0.8095
20°/15.6° C..... .8051

Boiling range

Distillate, percent	Temp., °C., corrected to 760 mm	Distillate, percent	Temp., °C., corrected to 760 mm
Initial boiling point	78.5	50.0	79.8
1.1	78.7	60.0	79.9
3.3	78.9	70.0	80.0
6.7	79.0	80.0	80.3
10.0	79.1	90.0	80.5
14.5	79.2	95.0	81.9
17.8	79.3	96.0	82.5
20.0	79.3	97.0	83.2
23.0	79.4	98.0	84.5
30.0	79.5	99.0	88.7
35.6	79.6	99.5	90.7
40.0	79.6		

0.2 percent residue; 0.3 percent lost

As determined by the Bureau of Mines, these physical properties agree closely with the specifications furnished by the manufacturer for the commercial product. The manufacturer also specified the product to be 92.3 percent ketone as determined by acetylation.

The boiling point of butanone as given in the International Critical Tables [6] is 79.6° C.

[6] International Critical Tables, first edition, 1928, vol. 3, p. 218.

USE OF BUTANONE

Butanone is at present employed in the manufacture of pyroxylin solutions, chiefly in the artificial leather and lacquer industries, and is also used in paint removers. Although at present limited largely to these uses, butanone has possibilities as a solvent in other fields.

TEST APPARATUS

Figures 1 and 2 show an explosion chamber used for exposing animals to vapor-air mixtures which were near or within the flammable range. The chamber was made from a second-hand compressed-air receiver by cutting off one end. It was 41 inches in diameter, 40 inches long on the sides, and 46 inches long at the center, the closed end being convex. The walls and convex end were steel plate, approximately ¼-inch thick. The open end was closed by covering it with a sheet of clear cellophane, *a*, held in place by a large rubber band made from the inner tube of an automobile tire. This cellophane served as a relief diaphragm in case an explosion occurred, and also admitted light. A 2-inch flanged hole, *b*, in the convex closed end of the cylinder, covered with a ¾-inch thick glass plate, served as an observation window. Animals in the chamber were observed without risk by means of a mirror, *c*, set in front of the transparent cellophane relief diaphragm and so inclined that a person at the protected end of the chamber could view the interior by reflection. A small opening at *d* was used for withdrawing samples of the chamber atmosphere for analysis. A stirring fan, *e*, was connected by a shaft through a close-fitting bushing to an externally located motor, *f*. The fan-shaft carried an externally located auxiliary fan for ventilating the space between the bushing and the motor (thus minimizing the possibility of a localized accumulation of flammable vapor-air mixture) and for drawing cooling air through the motor as required by the particular small commercial fan motor used for the apparatus. The internal stirring fan was used chiefly for keeping the vapor-air mixture homogeneous; in experiments in which an attempt was made to saturate the air with vapor it was also used to facilitate the evaporation of liquid from wicks, *g*, suspended in a reservoir of liquid. A wood floor, *h*, which had numerous 1-inch holes for circulation of air underneath, was placed in the bottom of the chamber. A wire screen, *i*, prevented the animals from rupturing the cellophane diaphragm. An opening about 4 inches in diameter at *j* was closed by a large removable cork, and through this opening guinea pigs were introduced into the chamber. The pigs were placed in a wire basket, *k*, suspended by a cord, and then lowered to the floor of the chamber. The pigs could thus be placed in the chamber after the desired vapor-air mixture had been created; and, by reversing the procedure, any animal or group could

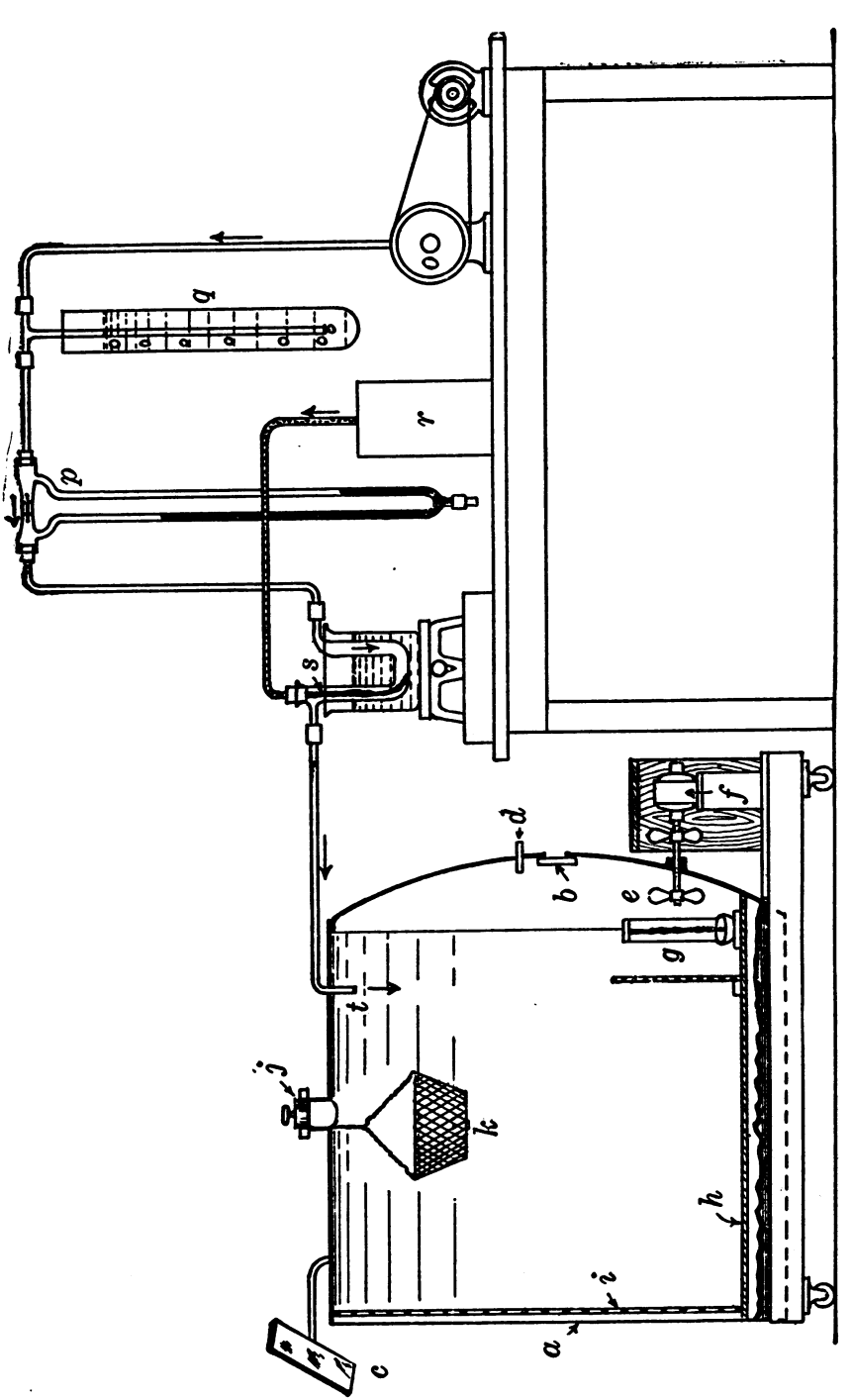

FIGURE 1.—Diagrammatic sketch of apparatus for making exposure to vapor-air mixtures close to or within the explosive limit.

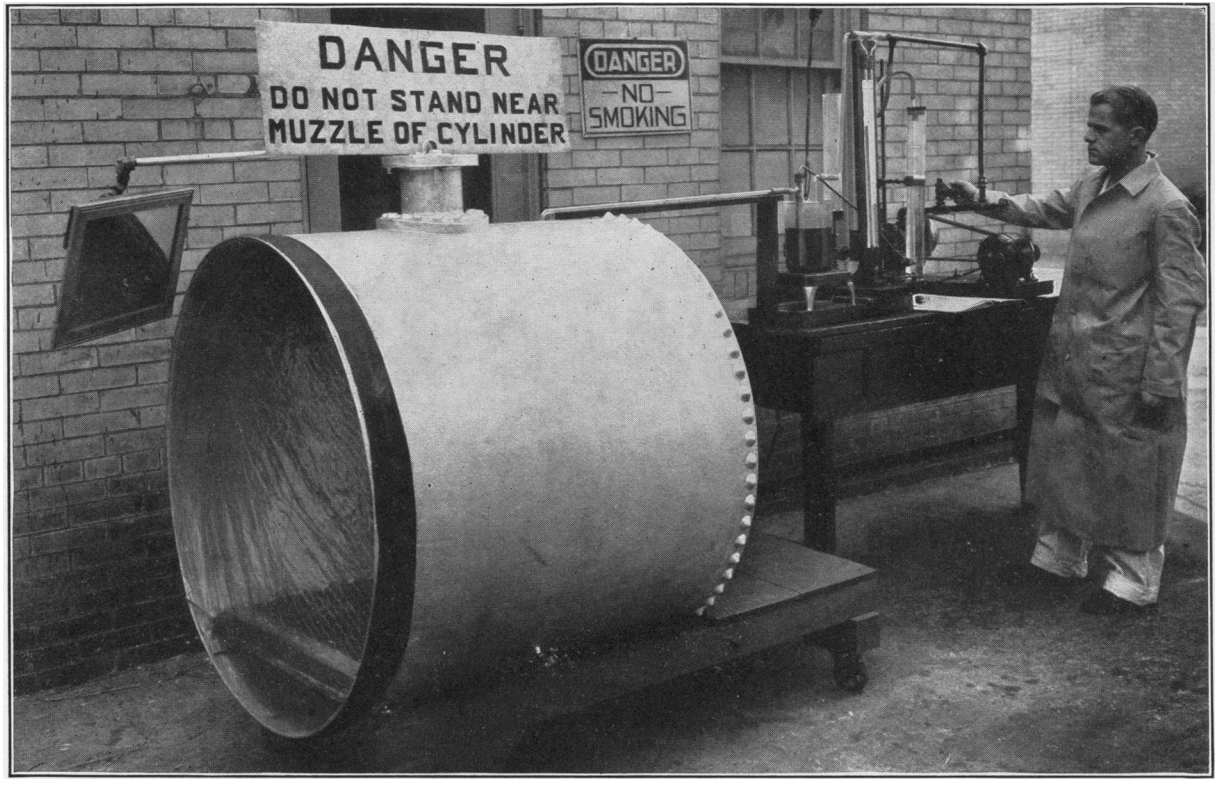

FIGURE 2.—PHOTOGRAPH OF APPARATUS FOR EXPOSING ANIMALS TO VAPOR-AIR MIXTURES CLOSE TO OR WITHIN THE EXPLOSIVE LIMIT.

be removed at any time during the experiment without significant loss of the chamber atmosphere.

The chamber was mounted on a truck frame to facilitate moving. Owing to the danger of destruction of laboratory windows and other laboratory equipment by the explosion waves set up by the flammation of the comparatively large volume of flammable vapor-air mixture, all experiments with this apparatus were conducted outside the laboratory.

Figures 1 and 2 also show the apparatus for vaporizing the liquid and preparing the vapor-air mixtures. These mixtures were usually prepared by a dynamic method whereby a measured flow of liquid material was continuously vaporized in a measured stream of air. A constant supply of air was delivered from the blower, *o*, through the flow-meter, *p*, the rate being controlled by the pressure regulator, *q*. The liquid to be vaporized was delivered at a constant rate by proportioning pump, *r* (shown only diagrammatically in fig. 1), onto the wick, *s*, contained in a U-tube immersed in an oil bath heated by a hot plate to a temperature above the boiling point of the liquid to be vaporized. The air supply passed over the wick and carried the vapor into the chamber at *t*. The escape of the vapor-air mixture was mainly around the edge of the diaphragm and to a slight extent at the stuffing box of the fan shaft. A slight internal pressure prevented any inward leakage. The amounts of liquid and air were varied to produce the desired concentrations, but the total volume of air passed through the chamber always exceeded two air changes an hour, which was sufficient to prevent oxygen deficiency or accumulation of carbon dioxide from the respiration of the animals.

In preparing the highest concentration available on complete saturation of the air (approximately 10 percent vapor in air by volume), all the chamber openings were closed and air was blown by means of the stirring fan across a series of wicks suspended in a reservoir of butanone. The fan and saturator were operated several hours before the pigs were placed in the chamber and continued during the entire experiment, in order to create and maintain as nearly a saturated condition as could be attained practically at the prevailing temperature, approximately 30° C.

Experiments with 0.33 percent butanone vapor in air, which is well below the lower flammable limit, were performed in a larger chamber, which has been described in a previous publication.[7]

[7] Yant, W. P., Schrenk, H. H., and Sayers, R. R.; Methanol antifreeze and methanol poisoning. Ind. & Eng. Chem., vol. 23 (1931), pp. 551-555.

COMPUTATION AND ANALYSIS OF VAPOR-AIR MIXTURES

For control purposes in creating experimental conditions, the concentrations of vapor in air were estimated by computation from the quantity of air flowing through the meter and the quantity of liquid delivered to the vaporizer. This procedure was necessarily omitted in the experiments with air saturated with butanone vapor, in which a static method was employed. All concentrations were finally determined during the course of the experiments by chemical analysis, and in some cases by adsorption by air-equilibrated charcoal.

The chemical method of analysis consisted of pipetting 50 cm^3 of a solution of N/1 sodium hydroxide into a flask, which was closed by a rubber stopper fitted with a glass stopcock. The flask was connected in series with a mercury U-gage and partly evacuated; then the stopcock was closed. This sample receiver was then connected to a well-purged sampling tube and filled by vacuum displacement. The volume of vapor-air taken was calculated from the U-gage measurement at the end of the evacuation procedure and at the prevailing temperature and barometric pressure. The tube was shaken to absorb the butanone; an excess of N/10 iodine was slowly added. The sodium hydroxide was permitted to stand for 15 minutes, then was neutralized with 2N sulphuric acid, and a slight excess (about 0.3 to 0.5 cm^3) of acid was added. The excess iodine was determined by titration with N/20 sodium thiosulphate solution.

Table 1 gives the results of analyses of a standard solution of butanone in water made as a check on the accuracy of the method of analysis.

TABLE 1.—*Results of the analysis of portions of a standard aqueous solution of butanone*

Butanone taken by computation from standard	Butanone found by analysis	Recovery, percent
Mg	*Mg*	
16.1	17.1	106
32.2	34.9	108
32.2	34.8	108
32.2	34.9	108
32.2	34.6	107
48.3	51.7	107
48.3	51.4	106
48.3	51.3	106

The average recovery in 8 determinations was 107 percent. In a report on the determination of methyl ethyl ketone, Cassar[8] has shown that if the reaction of 6 moles of iodine per mole of ketone is taken as 100 percent, a recovery of 110.6 percent is obtained. This

[8] Cassar, H. A.: Determination of isopropyl alcohol in presence of acetone, and of methyl ethyl ketone in presence of secondary butyl alcohol. Ind. & Eng. Chem., vol. 19 (1927), pp. 1061-1062.

increase is due apparently to the influence of a secondary reaction in which 10 moles of iodine react with 1 mole of ketone, as shown in the following equations:

$$CH_3CH_2COCH_3+3I_2+3NaOH \rightleftharpoons CHI_3+CH_3CH_2COOH+3NaI+2H_2O \quad (1)$$

$$CH_3CH_2COCH_3+5I_2+4NaOH \rightleftharpoons 2CHI_3+CH_3COOH+4NaI+3H_2O \quad (2)$$

On the basis of 110.6 being equivalent to 100 percent, the result, 107 percent, obtained by the Bureau of Mines for the commercial product used indicates it to be approximately 96.7 percent ketone. The commercial product was reported by the producers to contain 92.3 percent ketone, as determined by acetylization. The impurities in the ketone were also reported by the manufacturer to be primarily the corresponding secondary alcohol.

As an average recovery of 107 percent was obtained (table 1) for known amounts of the standard solution of commercial butanone, the values obtained for the amount of butanone in the vapor-air mixtures used in animal experiments (table 2) were corrected by multiplying the determined value by $\frac{100}{107}$, or 0.935.

Table 2 gives the concentrations computed from the volume of air and the amount of butanone vaporized, and the concentration found by chemical analysis for vapor-air mixtures used in animal experiments. The conversion from milligrams per liter, as determined chemically, to percent by volume is made on the basis that 1 gram molecular weight of butanone is equivalent to 22.4 liters of vapor at 0° C. and 760 mm Hg.

TABLE 2.—*Results of analysis of exposure atmospheres* [1]

Concentration by—		Concentration by—	
Computation	Analysis	Computation	Analysis
(2)	[3] 9.6	0.98	0.89
(2)	[3] 9.0	.92	.85
(2)	[3] 11.4	.96	1.18
(2)	8.7	.96	.96
4.2	3.6	1.02	.83
3.6	3.5	1.03	.91
3.6	3.2	.92	.86
3.2	3.6	.95	.95
3.2	2.9	.33	.30
3.3	2.9	.33	.32
1.04	1.05	.32	.35
1.01	1.22	.30	.32
.98	.89	.32	.28

[1] Concentration in percent by volume at 25° C. and 760 mm pressure. To convert to mg per liter, multiply by 29.5.
[2] Concentration obtained by recirculation of air (30° C., 740 mm pressure) over wicks wet with butanone. No computed composition.
[3] Determined by adsorption on air-equilibrated charcoal.

The maximum concentration attainable at 30° C. and 740 mm pressure averaged approximately 10 percent. The remainder of the results in table 2 represent experimental atmospheres prepared by continuously volatilizing a measured amount of butanone in a measured volume of air. For succeeding experiments this maximum of 10 percent was successively reduced by a factor of approximately one-third until no response was observed after 13.5 hours' exposure. By following this plan the general order of concentrations used was 10.0, 3.3, 1.0, and 0.33 percent by volume.

PROCEDURE FOR EXPOSING ANIMALS

In all experiments the desired concentration was created and analyzed before the guinea pigs were admitted. The pigs were exposed in groups of 6, several such groups being included in each experiment to permit study of the time-concentration effect. In the use of the explosion chamber, the animals to be exposed longest were admitted first. The second and other groups were added at a time which would permit the predetermined period of exposure for each group and allow the exposure of all to be terminated simultaneously. This procedure was usually reversed in the use of the chamber for nonflammable vapor-air mixtures. All the animals used for exposure to a particular vapor-air mixture were started at the same time, and groups were removed after predetermined intervals. Chemical analyses were continued during the course of exposure.

The description and information regarding the care of animals will be found in the report on ethylene dichloride.[9]

RESULTS OF TESTS

This report presents summarized results pertinent to signs or symptoms, fatality, and gross pathology.

OBJECTIVE SYMPTOMS

Control animals.—No signs or symptoms were exhibited by the 24 control guinea pigs taken at random from the stock animals used in these tests. No deaths occurred.

Exposed animals.—The signs or symptoms exhibited by animals exposed to butanone vapor in the order of their occurrence were as follows: Irritation of the nose and eyes manifested by rubbing nose with the forepaws and squinting; lacrimation; incoordination; narcosis; gasping type of respiration; and death. Table 3 gives the average time necessary to produce these symptoms by various concentrations of butanone vapor in air. The figures given indicate the average time for occurrence of the symptom, excepting those in parentheses, which

[9] See I, footnote 5.

indicate that the particular symptom did not occur in the maximum period of exposure as given.

TABLE 3.—*Signs and symptoms produced in guinea pigs exposed to vapors of butanone*

Type of symptom	Concentration of vapor in percent by volume			
	10.0	3.3	1.0	0.33
	Duration of exposure, minutes			
Nose irritation (rubbing nose)	(1)	1	2	[2] (810)
Eye irritation (squinting)	(1)	1	4	[2] (810)
Lacrimation	1	4	40	[2] (810)
Incoordination	3–5	18–30	90	[2] (810)
Narcosis (unconsciousness)	10–11	48–90	240–280	[2] (810)
Gasping-type respiration	20–30	180	[2] (810)	[2] (810)
Death	45–55	200–260	[2] (810)	[2] (810)

[1] Evident almost immediately after beginning exposure.
[2] Not observed during maximum exposure as given in parentheses.

No abnormal signs were observed during or following an exposure of 810 minutes to 0.33 percent butanone vapor in air by volume. Signs of irritation of the nose and eyes occurred in 2 and 4 minutes, lacrimation in 40 minutes, incoordination in 90 minutes, and unconsciousness in 240 to 280 minutes, but no gasping respiration or deaths occurred during or following an exposure of 810 minutes to 1.0 percent vapor in air. The time for occurrence of these symptoms decreased rapidly with increases in concentration, and death was produced by 45 and 200 minutes' exposure to 10.0 and 3.3 percent vapor in air, respectively.

GROSS PATHOLOGY

Control animals.—The 24 control animals killed for autopsy exhibited no significant gross pathology.

Exposed animals.—The gross pathological findings in animals that died during exposure (see fig. 3) were slight congestion of the brain and marked congestion of the systemic organs. The cornea of all pigs exposed to 10 percent vapor for 30 minutes or more became opaque. This condition gradually improved in pigs that lived 4 and 8 days following exposure, and at the end of 8 days the eyes were nearly normal. This condition was not observed in animals exposed to lower concentrations.

The lungs of the animals that died were emphysematous and markedly congested. Exposure to conditions which caused marked incoordination, narcosis, and a gasping type respiration produced a slight congestion of the brain, with moderate to marked congestion of lungs, liver, and kidneys in animals killed immediately after exposure. These findings were absent in nearly all animals killed for autopsy 4 to 8 days following exposure.

SUMMARY OF FATALITY AND PHYSIOLOGICAL RESPONSE

Figure 3 shows graphically the fatality and summary of the response of guinea pigs exposed to butanone vapor in air. The results of each experiment are designated by a symbol which represents one of four different degrees of severity. The symbols describe the results obtained for the majority of a group of 6 animals exposed to a given condition. In addition to representing the response of each group by symbols, the symbols have been separated into three general fields or zones of probable response.

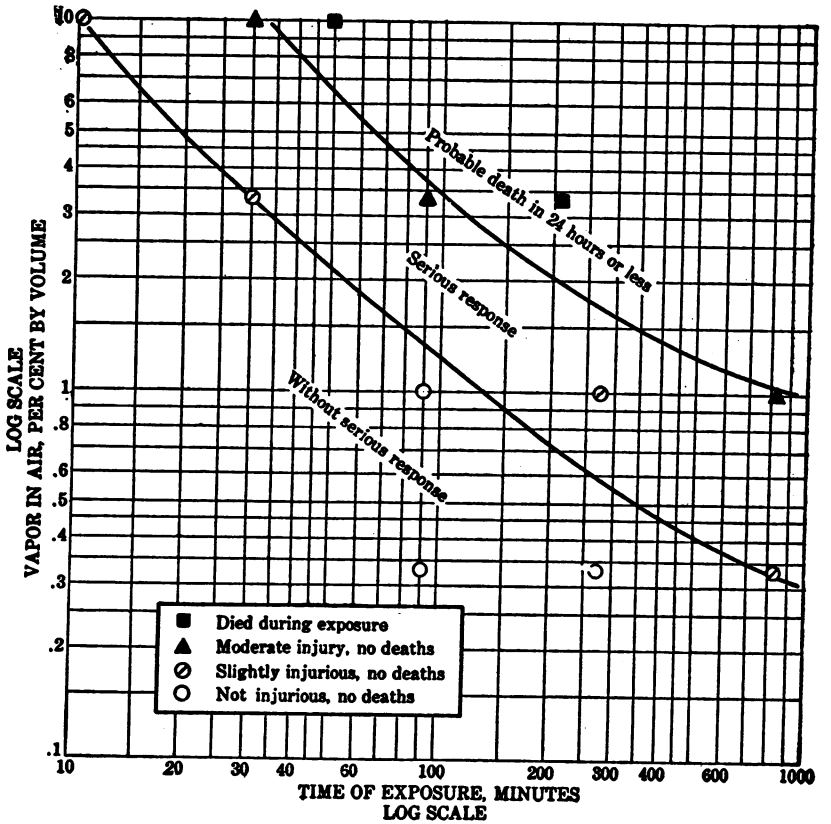

FIGURE 3.—Acute effects of exposure of guinea pigs to butanone vapor in air.

Table 4 gives concentrations, obtained by direct experiment or extrapolated from table 3 and figure 3, which produce the degrees of response generally reported for noxious gases. These data may be compared with toxicological data for other compounds.[10] [11] [12] [13] [14]

[10] See footnote 5.

[11] Sayers, R. R., Yant, W. P., Thomas, B. G. H., and Berger, L. B.: Physiological response attending exposure to methyl bromide, methyl chloride, ethyl bromide, and ethyl chloride. Pub. Health Bull. 185 (1929).

[12] International critical tables, first edition, 1927, vol. 2, p. 318; also see errata sheet, vol. 2.

[13] Henderson, Y., and Haggard, H. W.: Noxious gases. Am. Chemical Soc. Monograph No. 35 (1927). Chemical Catalog Co., New York.

[14] Flury, F., and Zernik, F.: Schädliche Gase. Berlin, 1931. Verlag von Julius Springer.

TABLE 4.—*Acute effects of exposure of guinea pigs to butanone vapor in air*

Acute effects after various periods of exposure	Concentration, percent by volume in air
Kills in a few minutes	(1)
Dangerous to life in 30 to 60 minutes	5.0–10.0
Maximum amount for 60 minutes without serious disturbance	1.0
Maximum amount for several hours without serious disturbance	0.3

[1] Not produced by 10 percent vapor in air, the highest concentration obtained in a closed chamber by extended recirculation of air (30° C., 740 mm pressure) over wicks wet with butanone.

CAUSE OF DEATH DURING EXPOSURE

It is not clear whether death was due to irritation of the lungs or to a state of narcosis that terminated in death. It is noteworthy that without exception the animals either died during exposure or recovered. This indicates that the irritation of the respiratory center was secondary to the narcotic action. In some instances the animals were unconscious for several hours after exposure terminated (30 minutes' exposure to 10 percent, 90 minutes to 3.3 percent, and 810 minutes to 1 percent), and in one instance (30 minutes to 10 percent) did not regain consciousness until 8 to 10 hours after exposure, but were approaching normal activity 24 hours after exposure and appeared normal in activity within 48 hours. Opacity of the cornea persisted in some cases for the 8-day period before the pigs were killed for autopsy.

WARNING PROPERTIES AND HAZARDS OF ACUTE POISONING

Men momentarily exposed to 3.3 and approximately 10 percent vapor in air pronounced the atmosphere intolerable because of irritation to the eyes and nasal passages. One percent vapor in air was found to have a strong odor and to be almost intolerable from irritation to the eyes and nose after several inhalations; 0.33 percent vapor had a moderate to strong odor and was moderately irritating to the eyes and nose.

Concentrations apparently harmless to guinea pigs after several hours' exposure have distinct warning properties of both odor and irritation, and concentrations which produced no serious effects in 1 hour were practically intolerable.

WARNING PROPERTIES AND EXPLOSION HAZARDS

The explosion hazard of butanone vapor is not to be ignored. The intensity of odor and irritating properties are high enough, however, to give distinct warning characteristics to vapor-air mixtures considerably below the flammable range, which may be considered to be about 2 percent. The upper limit probably is not greater than 12 percent.

SUMMARY AND CONCLUSIONS

The acute physiological response of guinea pigs to air containing butanone (methyl ethyl ketone) vapor was determined. The concentrations of the vapor ranged from those that produced death to those that produced no effect after several hours' exposure. The signs of response, fatality, and gross pathology are given. The warning properties as studied by the exposure of persons are described.

The symptoms are principally those of eye and nose irritation, and narcosis, the latter being apparently the most significant. Animals that did not die during exposure recovered.

The principal gross pathological findings immediately after exposure were congestion, edema, and hemorrhage of vital organs, death being due to a narcosis terminating in death.

At room temperature it was impossible to attain a concentration that would kill guinea pigs in a few minutes. Exposure to 5- to 10-percent vapor is considered dangerous to the life of guinea pigs after 30 to 60 minutes. One percent is considered the maximum amount for 60 minutes without serious disturbance and 0.3 percent the maximum amount for several hours without serious disturbances.

Butanone has a distinct odor and is markedly irritating to the nose and eyes of man in concentrations found to be harmful to guinea pigs. It also has moderate warning properties (odor and eye and nose irritation) in concentrations apparently harmless to guinea pigs after several hours' exposure. Flammable mixtures of the vapor in air are practically intolerable to man because of odor, and eye and nose irritation.

ACKNOWLEDGMENTS

Acknowledgment, with thanks, is made to Senior Surgeon R. R. Sayers, United States Public Health Service, formerly chief, Health and Safety Branch, United States Bureau of Mines, for consultation and advice in this investigation, and to John Chornyak, formerly medical officer in charge, pathological laboratory, and Acting Assistant Surgeon S. H. Black, United States Public Health Service, formerly assistant surgeon, United States Bureau of Mines, for making the pathological examinations.

DEATHS DURING WEEK ENDED AUG. 17, 1935

[From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce]

	Week ended Aug. 17, 1935	Corresponding week, 1934
Data from 86 large cities of the United States:		
Total deaths	6,956	7,082
Deaths per 1,000 population, annual basis	9.7	9.9
Deaths under 1 year of age	510	560
Deaths under 1 year of age per 1,000 estimated live births	47	52
Deaths per 1,000 population, annual basis, first 33 weeks of year	11.7	11.7
Data from industrial insurance companies:		
Policies in force	67,585,751	67,567,192
Number of death claims	11,014	11,690
Death claims per 1,000 policies in force, annual rate	8.5	9.0
Death claims per 1,000 policies, first 33 weeks of year, annual rate	10.1	10.3

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 Aug. 24, 1935, and Aug. 25, 1934

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended Aug. 24, 1935, and Aug. 25, 1934

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934
New England States:								
Maine	1	5	----	----	38	1	0	0
New Hampshire	----	1	----	----	----	----	0	0
Vermont	----	----	----	----	12	19	0	0
Massachusetts	6	12	----	----	21	18	0	1
Rhode Island	2	----	----	----	2	1	0	0
Connecticut	2	1	----	2	16	7	1	1
Middle Atlantic States:								
New York	10	20	[1] 1	[1] 8	146	62	5	4
New Jersey	1	14	3	10	32	22	2	1
Pennsylvania [2]	29	20	----	----	39	156	0	6
East North Central States:								
Ohio	11	13	1	2	17	5	1	0
Indiana	11	15	47	11	2	5	4	0
Illinois	15	24	3	20	32	61	7	5
Michigan	8	3	----	----	31	9	0	0
Wisconsin	2	4	20	9	56	55	1	2
West North Central States:								
Minnesota	1	8	1	----	2	6	0	0
Iowa	5	1	2	----	3	9	2	2
Missouri	18	15	28	3	6	14	3	0
North Dakota	2	6	18	----	8	3	0	0
South Dakota	3	1	----	----	----	8	1	0
Nebraska	11	2	----	----	1	3	0	3
Kansas [3]	3	13	1	----	4	4	1	3
South Atlantic States:								
Delaware	----	----	----	----	4	----	0	0
Maryland [3] [4]	6	4	----	146	1	3	4	0
District of Columbia	9	3	1	----	1	----	6	1
Virginia [4]	28	22	----	----	12	17	3	0
West Virginia	20	14	10	17	10	29	1	1
North Carolina [5]	21	41	----	1	----	31	1	1
South Carolina [3]	9	4	45	81	1	4	0	0
Georgia [5]	18	11	----	----	----	----	0	1
Florida	3	7	1	----	4	3	0	0

See footnotes at end of table.

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended Aug. 24, 1935, and Aug. 25, 1934—Continued

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934
East South Central States:								
Kentucky	22	31			31	74	0	1
Tennessee	11	10	12	13	6	24	5	2
Alabama [5]	33	33	5	6		75	1	1
Mississippi [3]	19	14					0	0
West South Central States:								
Arkansas	11	8	5	1			0	1
Louisiana	12	12	19	5	11	10	1	0
Oklahoma [2 6]	9	3	5	1	4	2	1	0
Texas [5]	39	43	12	11		6	0	0
Mountain States:								
Montana [4]		1		5	4	8	0	0
Idaho			1		2		0	0
Wyoming [4]					18	1	0	0
Colorado	9	4			6	4	0	0
New Mexico	2	1		3		5	1	1
Arizona	3	1	4	4	2	2	0	0
Utah [3]	1	1			1	4	0	0
Pacific States:								
Washington					17	6	0	0
Oregon		1	3	17	43	4	0	1
California	23	13	10	5	87	35	4	0
Total	449	460	258	381	733	815	56	39
First 34 weeks of year	18,569	20,906	104,369	49,568	696,212	669,077	4,221	1,630

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934
New England States:								
Maine	8	0	1	3	0	0	6	7
New Hampshire	4	0		1	0	0	0	1
Vermont	4	1	1	1	0	0	0	0
Massachusetts	112	4	49	46	0	0	3	3
Rhode Island	39	0	2	6	0	0	1	1
Connecticut	40	1	6	3	0	0	2	1
Middle Atlantic States:								
New York	291	12	67	101	0	0	37	30
New Jersey	26	2	23	20	0	0	10	7
Pennsylvania [3]	11	8	88	91	0	0	24	26
East North Central States:								
Ohio	2	10	51	67	0	0	27	45
Indiana	2	1	22	22	0	1	11	38
Illinois	9	14	83	74	0	0	51	41
Michigan	87	9	23	49	0	1	14	16
Wisconsin	10	3	42	27	0	7	2	4
West North Central States:								
Minnesota	3	1	26	9	0	0	21	13
Iowa	1	2	16	9	0	1	4	7
Missouri	1	1	21	17	0	0	23	52
North Dakota	2	1	9	5	0	0	1	2
South Dakota	1	1	3	3	0	0	3	1
Nebraska	1	2	1	11	2	0	0	10
Kansas [3]	0	2	11	13	0	0	16	11
South Atlantic States:								
Delaware	0	2	1	1	0	0	4	0
Maryland [3 4]	6	0	18	18	0	0	23	20
District of Columbia	7	1	5	7	0	0	4	0
Virginia [4]	39	2	16	30	0	0	41	34
West Virginia	4	6	26	19	0	0	28	25
North Carolina [5]	11	0	15	23	1	0	22	20
South Carolina [3]	3	0	2	4	0	0	20	19
Georgia [5]	0	1	5	7	0	0	30	52
Florida	1	0	2	2	0	0	1	0

See footnotes at end of table.

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended Aug. 24, 1935, and Aug. 25, 1934—Continued

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934	Week ended Aug. 24, 1935	Week ended Aug. 25, 1934
East South Central States:								
Kentucky	36	9	20	9	0	0	81	72
Tennessee	6	8	15	28	0	0	47	71
Alabama [5]	1	5	3	14	0	0	22	52
Mississippi [3]	1	1	8	5	0	0	4	18
West South Central States:								
Arkansas	1	0	8	1	3	0	0	5
Louisiana	6	1	2	6	0	0	22	36
Oklahoma [3 6]	0	1	4	9	0	0	35	23
Texas [5]	4	5	31	20	16	0	58	44
Mountain States:								
Montana [4]	0	48	3	3	0	0	3	14
Idaho	0	8	6	-------	0	0	1	2
Wyoming [4]	0	1	2	5	1	0	0	0
Colorado	0	1	15	7	0	0	3	9
New Mexico	0	0	14	1	0	0	11	7
Arizona	0	7	3	8	0	0	3	5
Utah [3]	1	1	16	2	0	0	0	1
Pacific States:								
Washington	2	42	8	10	4	9	12	3
Oregon	0	1	17	10	1	0	8	5
California	24	63	67	58	2	0	11	16
Total	807	289	877	885	30	19	750	869
First 34 weeks of year	4,329	4,354	181,256	149,045	5,341	3,770	10,000	12,071

[1] New York City only.
[2] Epidemic encephalitis, week ended Aug. 24, 1935, 44 cases, as follows: Pennsylvania, 39; Kansas, 3; South Carolina, 1; Oklahoma, 1.
[3] Week ended earlier than Saturday.
[4] Rocky Mountain spotted fever, week ended Aug. 24, 1935, 10 cases, as follows: Maryland, 4; Virginia, 4; Montana, 1; Wyoming, 1.
[5] Typhus fever, week ended Aug. 24, 1935, 41 cases, as follows: North Carolina, 2; Georgia, 10; Alabama, 19; Texas, 10.
[6] 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
July 1935										
Florida	1	20	1	130	15	1	3	12	0	36
Georgia	1	44	16	565	10	37	4	8	0	166
Idaho	1	-------	6	-------	9	-------	0	14	4	-------
Illinois	43	122	46	81	1,291	2	16	824	1	79
Kansas	8	21	16	19	161	-------	4	89	17	71
Louisiana	2	72	69	687	52	18	16	17	0	101
Massachusetts	-------	30	-------	1	595	3	46	281	0	13
Oklahoma [1]	3	14	63	277	19	32	1	40	-------	130
Oregon	2	2	22	2	192	-------	1	74	14	7
Rhode Island	2	11	-------	-------	493	-------	15	20	0	2
South Dakota	-------	13	-------	2	33	-------	-------	20	28	6
Texas	7	97	72	3,976	78	57	3	52	7	132
Virginia	14	37	139	35	211	31	246	51	1	88
Washington	4	5	14	-------	373	-------	1	77	70	7
West Virginia	7	40	87	-------	77	-------	-------	58	0	90
Wisconsin	9	12	102	8	2,686	-------	5	454	37	7

[1] Exclusive of Oklahoma City and Tulsa.

July 1935

	Cases
Actinomycosis:	
Massachusetts	1
Anthrax:	
Louisiana	2
Chicken pox:	
Florida	7
Georgia	20
Idaho	3
Illinois	407
Kansas	31
Louisiana	4
Massachusetts	379
Oklahoma [1]	9
Oregon	62
Rhode Island	30
South Dakota	15
Texas	58
Virginia	55
Washington	158
West Virginia	8
Wisconsin	584
Dengue:	
Florida	3
Georgia	7
Illinois	1
Texas	3
Dysentery:	
Florida (amoebic)	1
Georgia (amoebic)	1
Georgia (bacillary)	23
Illinois (amoebic)	10
Illinois (bacillary)	8
Kansas (amoebic)	1
Kansas (bacillary)	1
Louisiana (amoebic)	9
Massachusetts (amoebic)	1
Massachusetts (bacillary)	1
Oklahoma [1]	97
Oregon (amoebic)	1
Texas (bacillary)	66
Virginia (amoebic)	1
Virginia (bacillary and diarrhea)	1,231
Washington (amoebic)	1
Wisconsin (amoebic)	2
Epidemic encephalitis:	
Illinois	7
Kansas	3
Louisiana	1
Massachusetts	9
Oregon	4
Texas	2
Washington	1
German measles:	
Illinois	228
Kansas	9
Massachusetts	687
Rhode Island	11
Washington	78
Wisconsin	702
Hookworm disease:	
Georgia	179
Louisiana	21

July 1935—Continued

	Cases
Impetigo contagiosa:	
Illinois	1
Kansas	1
Oklahoma [1]	6
Oregon	5
Washington	3
Lead poisoning:	
Illinois	16
Massachusetts	1
Leprosy:	
Louisiana	3
Mumps:	
Florida	57
Georgia	68
Idaho	1
Illinois	247
Kansas	129
Louisiana	2
Massachusetts	241
Oklahoma [1]	16
Oregon	112
Rhode Island	34
South Dakota	29
Texas	145
Virginia	133
Washington	125
Wisconsin	910
Ophthalmia neonatorum:	
Illinois	4
Virginia	1
Paratyphoid fever:	
Georgia	1
Illinois	9
Kansas	19
Louisiana	2
Oregon	3
Rhode Island	2
Texas	2
Virginia	17
Puerperal septicemia:	
Illinois	1
Rabies in animals:	
Illinois	25
Louisiana	19
Massachusetts	17
Washington	5
Rabies in man:	
Georgia	1
Kansas	1
Louisiana	1
Rocky Mountain spotted fever:	
Idaho	1
Oregon	5
South Dakota	2
Virginia	11
Washington	1
West Virginia	1
Scabies:	
Oregon	7
Septic sore throat:	
Georgia	12
Illinois	3
Kan as	12
Louisiana	3
Massachusetts	15
Oklahoma [1]	24
Oregon	2

July 1935—Continued

	Cases
Septic sore throat—Con.	
Virginia	4
Washington	1
Wisconsin	7
Tetanus:	
Georgia	1
Illinois	4
Kansas	7
Louisiana	4
Massachusetts	4
Virginia	5
Trachoma:	
Georgia	4
Illinois	92
Massachusetts	7
Oklahoma [1]	3
Rhode Island	2
Wisconsin	1
Trichinosis:	
Illinois	4
Massachusetts	1
South Dakota	1
Tularaemia:	
Georgia	3
Louisiana	1
Texas	1
Virginia	4
Washington	1
Typhus fever:	
Florida	5
Georgia	53
Illinois	1
Louisiana	3
Texas	23
Virginia	2
Undulant fever:	
Georgia	7
Illinois	34
Kansas	15
Louisiana	6
Massachusetts	3
Texas	5
Virginia	3
Washington	3
Wisconsin	7
Vincent's infection:	
Illinois	14
Kansas	5
Oregon	7
Washington	1
Whooping cough:	
Florida	47
Georgia	100
Idaho	3
Illinois	1,216
Kansas	278
Louisiana	17
Massachusetts	347
Oklahoma [1]	101
Oregon	55
Rhode Island	79
South Dakota	20
Texas	208
Virginia	372
Washington	76
West Virginia	122
Wisconsin	1,243

[1] Exclusive of Oklahoma City and Tulsa.

WEEKLY REPORTS FROM CITIES

City reports for week ended Aug. 17, 1935

This table summarizes the reports received weekly from a selected list of 140 cities for the purpose of showing a cross section of the current urban incidence of the communicable diseases listed in the table. Weekly reports are received from about 700 cities, from which the data are tabulated and filed for reference.

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Maine:											
Portland	0		0	1	0	1	0	0	0	3	14
New Hampshire:											
Concord	0		0	0	0	0	0	0	0	0	7
Nashua	0			0		0	0		0	0	
Vermont:											
Barre											
Burlington	0		0	0	0	0	0	0	0	0	12
Rutland	1		0	0	0	0	0	0	0	0	5
Massachusetts:											
Boston	0		0	9	9	18	0	6	4	21	193
Fall River	0		0	0	0	1	0	2	0	1	29
Springfield	0		0	0	1	1	0	1	1	3	20
Worcester	0		0	0	2	3	0	1	0	3	39
Rhode Island:											
Pawtucket	0			0		0	0		0	0	
Providence	2	2	1	8	3	4	0	2	1	3	46
Connecticut:											
Bridgeport	0		0	1	1	2	0	1	0	0	28
Hartford	2			0		0	0		0	18	38
New Haven	0		1	0	4	0	0	0	0	0	33
New York:											
Buffalo	2		0	2	9	10	0	4	0	25	103
New York	8	2	0	78	59	28	0	95	18	116	1,213
Rochester	0		0	1	1	4	0	1	1	7	49
Syracuse	0		0	16	1	2	0	1	0	29	44
New Jersey:											
Camden	0		0	0	1		0	0	1	10	26
Newark	0	1	0	2	1	3	0	9	0	29	80
Trenton	0		0	0	0	1	0	2	0	0	29
Pennsylvania:											
Philadelphia	4	2		8	14	16	0	19	5	75	343
Pittsburgh	1		0	1	5	5	0	8	1	21	108
Reading	0		0	1	0	0	0	0	0	2	30
Scranton	0			0		2	0		0	3	
Ohio:											
Cincinnati	1	1	1	0	3	4	0	6	2	4	
Cleveland	4	8		11	7	3	0	11	5	59	175
Columbus	0		0	0	3	1	0	2	1	4	63
Toledo	0		0	6	2	3	0	0	2	17	57
Indiana:											
Anderson	0		0	0	2	0	0	1	0	4	15
Fort Wayne	0		0	0	1	1	0	1	0	0	27
Indianapolis	1		0	3	7	2	0	6	1	17	93
South Bend	0		0	0	0	1	0	0	0	0	10
Terre Haute	0		0	0	0	0	0	0	1	0	15
Illinois:											
Alton	0		0	0	0	0	0	0	0	0	5
Chicago	3	6	2	24	29	45	0	33	2	147	612
Elgin	1		0	0	1	0	0	0	0	5	5
Moline	0		0	0	0	0	0	0	0	0	7
Springfield	0		0	0	1	0	0	0	0	6	20
Michigan:											
Detroit	1		0	11	9	6	0	16	4	155	237
Flint	0		0	0	0	4	0	0	1	11	17
Grand Rapids	0		0	0	1	3	0	0	1	12	22
Wisconsin:											
Kenosha	0			0		1	0		0	2	4
Milwaukee	0		0	25	2	6	0	1	0	84	76
Racine	0		0	1	0	5	0	0	0	9	10
Superior	0		0	1	1	0	0	0	0	1	5
Minnesota:											
Duluth	0		0	0	1	0	0	0	0	1	17
Minneapolis	1		0	4	0	13	0		10	1	103
St. Paul	0		0	0	2	2	0	2	3	11	50
Iowa:											
Cedar Rapids	0			0		1	0		0	3	
Davenport	1			0		0	0		0	0	
Des Moines	0			0		0	0		0	0	26
Sioux City	0			0	0	1	0		0	1	
Waterloo	1			0		0	0		0	0	

City reports for week ended Aug. 17, 1935—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Missouri:											
Kansas City	0	------	0	3	2	1	0	4	0	0	68
St. Joseph	1	------	0	0	0	0	0	1	0	2	14
St. Louis	4	------	0	1	3	2	0	6	1	6	140
North Dakota:											
Fargo	0	------	0	0	0	1	0	0	0	1	7
Grand Forks	0	------	-------	0	-------	0	0	-------	0	2	-------
Minot	0	------	-------	0	-------	0	0	-------	0	0	7
Nebraska:											
Omaha	1	------	0	0	0	0	0	1	0	0	51
Kansas:											
Topeka	2	------	0	0	1	0	0	0	0	8	6
Wichita	0	------	0	0	1	0	0	-------	0	1	29
Delaware:											
Wilmington	0	------	1	0	2	0	0	0	0	0	21
Maryland:											
Baltimore	4	------	1	0	6	3	0	7	1	19	166
Cumberland	0	------	0	0	0	0	0	0	0	0	8
Frederick	0	------	0	0	1	0	0	0	1	0	3
District of Columbia:											
Washington	9	------	0	7	5	3	0	17	3	1	146
Virginia:											
Lynchburg	0	------	0	0	1	0	0	1	6	13	12
Norfolk	0	------	0	0	1	1	0	1	3	0	28
Richmond	0	------	1	0	4	1	0	3	0	0	59
Roanoke	0	------	0	0	1	1	0	0	2	0	17
West Virginia:											
Charleston	2	------	-------	0	-------	0	0	-------	0	0	12
Huntington	2	------	-------	0	-------	2	0	-------	1	3	-------
Wheeling	0	------	0	1	0	0	0	3	1	2	16
North Carolina:											
Gastonia	0	------	-------	0	-------	0	0	-------	0	0	3
Raleigh	1	------	0	0	2	1	0	0	1	2	9
Wilmington	0	------	0	0	1	0	0	1	0	0	10
Winston-Salem	0	------	0	0	1	0	0	1	1	2	17
South Carolina:											
Charleston	1	4	-------	0	0	0	0	2	1	0	21
Columbia	0	------	0	0	5	0	0	2	0	0	43
Greenville	0	------	0	0	1	0	0	0	0	0	3
Georgia:											
Atlanta	1	------	0	0	4	2	0	3	0	3	71
Brunswick	0	------	0	0	0	0	0	1	0	0	6
Savannah	2	------	0	0	0	1	0	2	11	1	31
Florida:											
Miami	3	1	0	0	0	1	0	1	2	0	23
Tampa	0	1	1	1	2	0	0	1	0	3	24
Kentucky:											
Ashland	0	------	-------	0	-------	0	0	-------	1	0	-------
Covington	2	------	0	0	0	1	0	2	0	1	16
Lexington	1	------	0	0	1	2	0	2	1	0	17
Louisville	1	------	0	3	2	1	0	6	4	22	62
Tennessee:											
Knoxville	0	------	0	0	0	0	0	4	2	2	19
Memphis	1	------	0	0	4	1	0	4	0	0	94
Nashville	0	------	0	0	2	2	0	2	2	0	55
Alabama:											
Birmingham	1	------	0	0	3	2	0	3	0	0	59
Mobile	0	------	-------	0	-------	1	0	-------	0	0	20
Montgomery	0	------	-------	0	-------	1	0	-------	1	0	-------
Arkansas:											
Fort Smith	-------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Little Rock	0	------	0	1	4	1	0	-------	0	0	-------
Louisiana:											
Lake Charles	0	------	0	0	1	0	0	0	1	0	14
New Orleans	6	------	0	2	5	2	0	6	6	3	140
Shreveport	1	------	0	0	2	0	0	1	0	0	37
Texas:											
Dallas	11	------	0	0	2	6	1	0	0	3	54
Fort Worth	2	------	0	0	1	2	0	2	0	1	39
Galveston	0	------	0	0	2	1	0	2	1	0	20
Houston	6	------	0	0	4	1	0	3	1	0	65
San Antonio	1	------	0	0	4	1	0	5	0	0	55
Montana:											
Billings	0	------	0	0	1	0	0	0	1	1	4
Great Falls	0	------	0	0	1	0	0	0	0	6	4
Helena	0	------	0	0	0	0	0	0	0	0	4
Missoula	0	------	0	0	0	0	0	0	0	0	3

City reports for week ended Aug. 17, 1935—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Idaho:											
Boise	0	------	0	0	0	0	0	0	0	0	7
Colorado:											
Colorado Springs	0	------	0	0	0	0	0	1	0	0	10
Denver	5	------	0	3	2	4	0	2	0	2	70
Pueblo	0	------	0	0	0	2	0	0	0	0	5
New Mexico:											
Albuquerque	1	------	0	0	1	0	0	3	0	0	17
Utah:											
Salt Lake City	0	------	0	1	2	6	0	1	0	17	31
Nevada:											
Reno	0	------	0	0	0	0	0	1	0	0	4
Washington:											
Seattle	0	------	--------	6	-------	1	0	--------	0	4	--------
Spokane	0	------	0	1	2	0	1	0	0	3	25
Tacoma	0	------	0	0	2	0	1	0	0	0	28
Oregon:											
Portland	0	------	0	1	1	4	0	0	0	0	50
Salem	0	------	--------	0	-------	2	0	--------	0	0	--------
California:											
Los Angeles	2	7	0	23	17	15	0	15	0	18	268
Sacramento	1	------	0	2	3	10	0	1	1	2	29
San Francisco	0	------	0	30	2	4	0	8	1	19	138

State and city	Meningococcus meningitis		Poliomyelitis cases	State and city	Meningococcus meningitis		Poliomyelitis cases
	Cases	Deaths			Cases	Deaths	
Massachusetts:				Missouri:			
Boston	0	0	77	St. Joseph	0	1	1
Fall River	0	0	15	St. Louis	1	1	1
Springfield	0	0	1	North Dakota:			
Worcester	0	0	3	Fargo	0	0	1
Rhode Island:				Nebraska:			
Pawtucket	0	0	1	Omaha	0	1	0
Providence	0	0	7	Kansas:			
Connecticut:				Topeka	1	0	0
Bridgeport	0	0	9	Wichita	1	0	0
Hartford	0	0	1	Maryland:			
New Haven	0	0	3	Baltimore	2	0	0
New York:				District of Columbia:			
New York	13	5	209	Washington	8	0	4
New Jersey:				Virginia:			
Camden	0	0	1	Lynchburg	0	0	1
Pennsylvania:				Norfolk	0	0	1
Philadelphia	0	0	5	Richmond	0	0	1
Pittsburgh	1	1	1	Roanoke	0	0	4
Ohio:				Georgia:			
Cincinnati	0	0	1	Atlanta	2	0	0
Cleveland	1	1	3	Kentucky:			
Indiana:				Louisville	0	0	20
Fort Wayne	1	0	0	Tennessee:			
Terre Haute	1	0	0	Memphis	3	0	0
Illinois:				Alabama:			
Chicago	3	0	1	Montgomery	0	--------	1
Moline	0	1	0	Louisiana:			
Springfield	0	0	1	New Orleans	0	0	1
Michigan:				Colorado:			
Detroit	0	0	26	Denver	1	1	0
Flint	0	0	9	Utah:			
Grand Rapids	0	0	7	Salt Lake City	0	0	1
Wisconsin:				Washington:			
Kenosha	0	0	1	Seattle	0	0	1
Racine	0	0	1	California:			
Superior	1	0	0	Los Angeles	0	1	9
Iowa:				Sacramento	0	0	1
Des Moines	1	--------	1	San Francisco	0	0	1
Sioux City	1	--------	0				

Epidemic encephalitis.—Cases: Bridgeport, 1; New York, 1; Detroit, 1; St. Louis, 2; Wichita, 1; Baltimore, 1.
Pellagra.—Cases: Philadelphia, 1; Wilmington, N. C., 1; Winston-Salem, 1; Savannah, 2; Birmingham, 1; Dallas, 1; San Francisco, 1.
Typhus fever.—Cases: Chicago, 1; Charleston, S. C., 1; Savannah, 1; Montgomery, 4; New Orleans, 2; Shreveport, 1; Dallas, 3.

FOREIGN AND INSULAR

CANADA

Provinces--Communicable diseases—2 weeks ended August 10, 1935.—During the 2 weeks ended August 10, 1935, certain communicable diseases were reported by the Department of Pensions and National Health of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chicken pox		1		36	132	29	28	4	15	245
Diphtheria		4	6	19	11	9	5			54
Dysentery				2						2
Erysipelas				4	4	2			1	11
Influenza					1				1	2
Lethargic encephalitis				1					1	2
Measles		5	24	99	411	100	40	8	49	736
Mumps					81	34	36	6	13	170
Paratyphoid fever		1			5					6
Pneumonia	1	1			10		1		10	23
Poliomyelitis				1	4	1		3		9
Scarlet fever		9	3	81	80	10	5	2	26	216
Trachoma						1			4	5
Tuberculosis	15	17	30	122	147	5	26	4	31	397
Typhoid fever			6	49	4	3	8	3	4	77
Undulant fever					8				1	9
Whooping cough		5		181	261	36	109	23	18	633

CZECHOSLOVAKIA

Communicable diseases—June 1935.—During the month of June 1935, certain communicable diseases were reported in Czechoslovakia as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax	2	1	Paratyphoid fever	6	1
Cerebrospinal meningitis	16	6	Poliomyelitis	4	1
Chicken pox	186		Puerperal fever	35	16
Diphtheria	1,485	107	Scarlet fever	1,698	28
Dysentery	18	2	Trachoma	81	
Influenza	73	11	Typhoid fever	293	27
Lethargic encephalitis	3	3	Typhus fever	11	
Malaria	519				

DENMARK

Communicable diseases—April–June 1935.—During the months of April, May, and June 1935, cases of certain communicable diseases were reported in Denmark as follows:

Disease	April	May	June	Disease	April	May	June
Cerebrospinal meningitis	9	5	7	Paratyphoid fever	8	14	21
Chicken pox	36	36	36	Poliomyelitis	11	22	14
Diphtheria and croup	335	333	285	Puerperal fever	13	14	11
Epidemic encephalitis	5	3	3	Scabies	466	427	376
Erysipelas	210	252	222	Scarlet fever	553	535	385
German measles	86	128	138	Syphilis	77	59	63
Gonorrhea	643	741	684	Tetanus, neonatorum	1	2	3
Influenza	23,459	10,923	3,604	Tetanus, traumatic	1		1
Malaria	4	4	8	Typhoid fever	1	1	5
Measles	13,808	15,183	9,643	Undulant fever (Bact. abort. Bang)	48	59	46
Mumps	762	753	421	Whooping cough	2,386	2,698	1,870
Paradysentery	35	25	17				

YUGOSLAVIA

Communicable diseases—July 1935.—During the month of July 1935, certain communicable diseases were reported in Yugoslavia as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax	98	5	Paratyphoid fever	39	1
Cerebrospinal meningitis	5	3	Poliomyelitis	7	1
Diphtheria	371	24	Scarlet fever	181	3
Dysentery	216	22	Sepsis	6	5
Erysipelas	159	11	Tetanus	55	25
Influenza	3		Typhoid fever	288	32
Measles	185	2	Typhus fever	49	3

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

NOTE.—A table giving current information of the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS for Aug. 30, 1935, pp. 1194–1210. A similar cumulative table will appear in the PUBLIC HEALTH REPORTS to be issued Sept. 27, 1935, and thereafter, at least for the time being, in the issue published on the last Friday of each month.

Cholera

Indo-China—Pnom-Penh.—During the week ended August 17,1935, 1 case of cholera was reported at Pnom-Penh, Indo-China.

Plague

China—Sinkiang Province.—During the week ended August 17, 1935, plague was reported at Kashgar and Oulouktchat, Sinkiang Province, China, about 25 miles from the Chinese and Russian Turkistan frontier.

Ecuador—Loja Province—Celica.—On July 20, 1935, 1 fatal case of pneumonic plague was reported at Celica, Loja Province, Ecuador.

Peru.—During the month of July 1935, 4 cases of plague with 3 deaths were reported in Peru, including 1 case of plague reported at the city of Lima, Peru.

Acute Spirochetal Jaundice

Mexico—Tampico.—According to a report dated August 24, 1935, 2 cases of acute spirochetal jaundice, with 1 death, had been reported in Tampico, Mexico, within the preceding 6 weeks. Sections of the liver, spleen, and kidney from the fatal case were sent to Mexico City for pathological diagnosis and were found negative for yellow fever.