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TULARAEMIA

(Rabbit Fever)

From the increasing number of human cases and deaths from tularaemia (rabbit fever) occurring each year it is apparent that many who hunt, handle, or consume the flesh of wild rabbits are unaware of the danger to man which may lurk in the small body of this animal. It would be well for the public to note that in 1938 there were in this country 2,088 cases with 139 deaths from this disease. The majority of persons contracting the disease had skinned or otherwise handled wild rabbits. During 1939, 2,200 cases were reported, and it is likely that the complete returns will show that approximately 150 deaths occurred among those cases.

Historically, tularaemia is of great interest to us because our knowledge of the disease is almost wholly the product of American scientific research. The condition, later to be known as tularaemia, was first described in 1910 by Dr. George W. McCoy of the Public Health Service in reporting a "plaguelike" outbreak among ground squirrels in Tulare County, Calif. McCoy and Chapin discovered and described the causative organism in 1912, calling it *Bacterium tularense* after Tulare County, where the disease was first observed. In 1919, Dr. Edward Francis of the Public Health Service, while studying "deer fly fever" in Utah, recognized its identity with McCoy's "plaguelike" disease of rodents and named the infection "tularaemia."

Subsequent research has disclosed the presence of human cases of the disease in 48 States and the District of Columbia and has traced the source of human cases to 24 forms of American wildlife. Since 1925 tularaemia has been recognized for the first time in 10 foreign countries.

WILDLIFE SOURCES OF TULARAEMIA

Wild rabbits and hares are the direct cause of over 90 percent of human cases in the United States. Rabbits raised under domestic conditions, although highly susceptible, have not been found naturally

infected, probably owing to their freedom from ticks. Market men, hunters, housewives, and others who dress rabbits with bare hands may become infected.

Horseflies have caused 68 cases in Utah and surrounding States. They bite on the exposed parts of the body. Thirty of 170 enrollees in a Civilian Conservation Corps camp in Utah became infected in July 1935. Their unusual sites of infection were located on the back, since the boys, when at work, were stripped to the waist.

Wood ticks have caused 53 cases in Montana and surrounding States. The dog tick has caused 73 cases, principally in the southern States. Ticks bite under the clothing or hidden in the hair.

Sheep contact has caused 12 cases in the Northwest among shearers, butchers, and herders, the infection entering the hands from contact with wood ticks and tick feces located in the wool. Sheep are only very slightly susceptible.

Insect bites (species undetermined) caused 9 cases. One infected person had picked ticks from a dog and crushed them with his fingers.

Tree squirrels had been dressed by 14 patients. Nine had killed and skinned opossums. One case each followed the skinning or dressing of a sage hen, coyote, deer, red fox, or bull snake. Two cases each followed like contact with quail, ground hog, muskrat, hog, or skunk. Two had been scratched by cats and 11 were bitten by cats. Single cases have resulted from bites of raccoon, skunk, coyote, tree squirrel, Montana ground squirrel, opossum, dog, hog, lamb, and a white rat; here contamination of the animal's mouth parts is assumed. The dissection of infected laboratory animals has caused 56 cases in laboratory workers.

Eating insufficiently cooked wild-rabbit meat caused 20 cases in 5 families in the United States, of whom 12 died.

A water-borne epidemic of 43 cases was reported in 1935 from Russia in peasants who drank water from a brook which was thought to have been contaminated by water rats. Early in 1940, officers of the Public Health Service reported that water in 3 streams in Montana had been found to be contaminated with *Bacterium tularense*. This discovery was incidental to studies of an outbreak of tularaemia in beaver.

EFFECT OF THE ORGANISM ON WILD RABBITS

The disease in wild rabbits causes the liver and spleen to become covered with small spots which may be seen when the carcass is being dressed. The germs invade and multiply in every tissue in the animal's body, including blood and muscles, ultimately causing its death. Ordinarily, only about 1 in every 100 rabbits in the wild state is infected, but occasionally the disease becomes epidemic among them and then it is not uncommon to find dead rabbits lying about in their natural habitats.

MECHANISM OF HUMAN INFECTION

The organism may be transmitted from one animal to another and from animal to man by the bite of insects, notably the wood tick, the dog tick, and the deer fly.

The majority of human infections are contracted as the result of the organism entering through a skin wound, inflicted at the time of infection or shortly before or shortly after the germs get on the skin. Infection may be caused by pricking the skin with a fragment of rabbit bone broken by a shot, by a cut from a skinning knife, or if animal blood or body secretions get into the smallest skin abrasion. Sometimes the infection penetrates the apparently unbroken skin of the hands but usually there is a minute cut or scratch through which the germs enter the body. Fingers soiled by rabbit blood may convey the infection to the eyes. Several serious outbreaks of tularaemia have been attributed to eating insufficiently cooked rabbit meat. The fact must not be lost sight of that the pelts of infected rabbits and other animals may also convey the infection.

SYMPTOMS OF TULARAEMIA IN MAN

On an average of about 3½ days after exposure illness begins suddenly with headache, chilliness, vomiting, fever, prostration, and aching pains all over the body. The symptoms are often mistaken for those of influenza. The sore, usually on the hand, develops into an ulcer, and the nearby lymph glands, at the elbow or in the armpit, become enlarged, tender, and painful, and later may develop into abscesses. Illness and fever last for about 3 weeks. Convalescence is slow and is characterized by great weakness and disability which may continue for 2 or 3 months. Most patients recover without permanent ill effects, but about 5 percent die, notably among those who develop pneumonia. One attack of the disease confers immunity.

PREVENTION OF INFECTION

Hunters, vacationists, butchers, housewives, and laboratory workers who handle rabbits and other wild game are especially exposed to tularaemia.

A wild rabbit should never be handled with the bare hands. Rubber gloves, so long as they are impervious, afford excellent protection, but they are easily pierced by skinning knife or by fragments of bone and the wearer must be alert to avoid even the most inconspicuous skin prick.

Immune persons only should be employed in laboratories working with known or presumably infected animal and insect hosts of the disease.

The liberal use of soap and water, followed by disinfection, is recommended to remove blood or other infected material from the hands. The same precaution should be observed after touching the fur of wild rabbits or other game killed in areas where tularaemia is known to exist.

Infected meat is rendered safe for food by thorough cooking, but the organism will remain alive and virulent in the red juices of partly cooked game.

Refrigeration for ordinary periods does not kill the organism causing tularaemia.

There is no specific preventive or curative treatment for the disease.

CONTROL LEGISLATION

Legislation designed to prevent the spread of tularaemia, by restricting the purchase and sale or handling of wild hares and rabbits, has been enacted in at least three States—Connecticut, New Hampshire, and Ohio.

EFFECT OF PETROLEUM ETHER EXTRACT OF MOUSE CARCASSES ON SKIN TUMOR PRODUCTION IN C57 BLACK MICE [1]

By JOHN J. MORTON, *Professor of Surgery, University of Rochester*, and G. BURROUGHS MIDER, *Research Fellow, National Cancer Institute, United States Public Health Service*

Lipoids have been implicated frequently in the genesis of mouse skin tumors. Roffo (*1*) ascribed a major role in the production of epidermoid neoplasms to cholesterol. Watson and Mellanby (*2*) found that a petroleum ether extract of normal mouse tissues enhanced the carcinogenic action of tar when applied at the site of tarring. Several carcinogenic agents have been found to be more effective in producing skin tumors when the test animals received a high fat diet (*3, 4, 5*).

The approach to the problem has been largely empirical, utilizing readily available materials. The experiments to be reported deal with substances extractable from mice which influence the production of skin tumors by a carcinogenic hydrocarbon. Those substances responsible for the results obtained may be capable of ultimate identification. The data have been analyzed by standard statistical methods.

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[1] From the Department of Surgery, University of Rochester School of Medicine and Dentistry, Rochester, N. Y. This investigation was aided by grants from the International Cancer Research Foundation and Mr. Simon Stein.

MATERIAL AND METHOD

C57 black mice have been used throughout these experiments. They are a closely inbred strain, developed at the Roscoe B. Jackson Memorial Laboratory, and have a relatively low incidence of spontaneous neoplasms (*6*). Spontaneous skin tumors are almost unknown in mice less than 1 year old. The animals were approximately 6 weeks old when painting was commenced. Sex distribution was equal within each group but breeding was prevented. The mice were kept in glass cages. They were fed a diet of Purina dog chow, water being available at all times.

Extracts were prepared from normal adult mice. Fresh minced mouse carcasses, from which the stomach and intestines had been excised, were refluxed with petroleum ether (maximum boiling point 50° C.) for 16 hours. The petroleum ether was removed by distillation under reduced pressure. This procedure gave a poor yield of extract.

A better yield was obtained by refluxing minced mouse carcasses with ethyl alcohol for 5 hours, the extractive being changed at hourly intervals. The filtered solution was concentrated by low pressure distillation. Two volumes of water were added to the residue and the mixture was shaken with petroleum ether.

The extracts prepared by both methods were yellow, turbid, oily, and had a characteristic odor. A grey-white, amorphous, greasy substance settled out on standing. The supernatant liquid was yellow and clear.

3:4-Benzpyrene[2] 0.5 percent in benzene was used as the carcinogenic agent. It was applied to the unepilated skin of the interscapular region twice weekly with a No. 6 camel's hair brush. Painting was continued for 14 weeks.

Control groups were painted with benzpyrene solution only. The mice that received extract were painted twice with benzpyrene. Thereafter the petroleum ether extract was applied to the same area with a No. 6 camel's hair brush 20 to 30 minutes before painting with the carcinogen. Each experimental mouse received a total of 28 paintings with 3:4-benzpyrene 0.5 percent in benzene and 26 with the extract during the 14-week period. The mice were then observed for 67 days (one hundred sixty-fifth day of experiment) when all survivors were sacrificed. Previous observations showed that the first skin cancer in C57 black mice painted twice weekly with 3:4-benzpyrene 0.5 percent in benzene usually arose during the fourteenth week of painting. This determined the duration of the painting period. The experiment was terminated at 165 days because a sharp rise in mortality occurred then.

[2] Obtained from Hoffman-LaRoche, Nutley, N. J., and used without further purification.

Each tumor was individually identified and its life history was recorded. A diagnosis of carcinomatous change in a papilloma was made by alteration in the growth rate, by ulceration, and, most important, by induration at the base. No biopsies were performed but all cancers and suspicious lesions were examined histologically when the animal died. Invasion of muscle was taken as the microscopic criterion of malignancy. The histologic and clinical diagnoses usually agreed. All previous diagnoses of malignancy were confirmed. Some suspicious lesions, classified as papillomata in the living mouse, showed unmistakable heterotopia on section. The error occasioned by this discrepancy was minimal.

The number of mice that were living when the first papilloma appeared was designated as the effective total. This figure was the basis for all computations respecting papillomata. The effective total for mice with carcinomata was determined in the same manner. All mice living when the first tumor appeared were considered capable of forming a tumor. Subsequent death of a mouse without tumor formation tended to dilute the statistics. Mortality was parallel in control and experimental groups.

The mean number of papillomata per mouse was obtained by dividing the total number of papillomata by the effective total. This value was affected adversely when tumor incidence was low. The presence of mice without tumor caused a wider variation. Larger differences between control and experimental groups were necessary to establish statistical significance.

The latent interval to the first papilloma and first carcinoma in each mouse was determined. The average of these values was designated the mean latent interval for papilloma and carcinoma for the group. The mean transition time was computed from the life histories of the individual tumors. One of us made all observations on the living animals, thus reducing individual variation.

RESULTS

The results of painting C57 black mice with benzpyrene 0.5 percent in benzene alone and of painting with petroleum ether extract of mouse carcasses prior to the application of the carcinogen are presented in table 1. Little variation exists among groups treated similarly at different times. Groups A and D and groups C and E were painted concurrently. Mortality was almost identical. Therefore, direct comparison of the totals for all mice treated in control and experimental groups is justified.

TABLE 1.—*The effect of petroleum ether extract of mouse carcasses on the production of skin tumors in C57 black mice painted with 3:4-benzpyrene 0.5 percent in benzene*

Factor	Benzpyrene only				Extract and benzpyrene		
	Group A	Group B	Group C	Total	Group D	Group E	Total
Papillomata							
Effective total	50	48	50	148	49	49	98
Number of mice with papillomata	37	39	35	111	46	43	89
Percent of mice with papillomata	74	81.2	78	77.7	94	88	90.8
Total number of papillomata	99	105	99	303	201	173	374
Mean number papillomata per mouse	1.98±0.27	2.18±0.26	1.98±0.28	2.05±0.27	4.02±0.36	3.53±0.27	3.78±0.32
Coefficient of variation	0.976	0.825	0.723	0.834	0.626	0.501	0.563
Mean latent period (days)	92.0±3.4	80.8±4.7	92.2±3.9	88.3±4.0	85.7±2.9	89.5±2.9	87.6±2.9
Coefficient of variation	0.367	0.352	0.257	0.315	0.324	0.241	0.235
Mean transition time to carcinoma (days)	44.4	50.9	46.6	47.3	42.6	35.6	39.1
Carcinomata							
Effective total	49	46	42	137	48	42	90
Number of mice with carcinoma	16	18	24	58	25	32	57
Percent of mice with carcinoma	32.6	39.1	57.1	42.3	52.1	76.2	63.3
Total number of carcinomata	16	20	25	61	27	35	62
Mean latent period (days)	138.0	134.3	147.1	139.8	135.6	128.6	132.1
Percent of papillomata that became malignant	16.1	19.0	25.1	20.1	13.4	20.2	16.5

More of the mice that were painted with extract and benzpyrene had papillomata than did those that were painted with benzpyrene only. The extract group also had a larger number of papillomata. The difference in each case is more than three times the standard error of the difference, and thus unlikely to be a chance phenomenon (7). The same observations apply to carcinomata. Again the differences are statistically significant.

The temporal factors show little variation. Petroleum ether extract of mouse carcasses did not accelerate the production of the first papilloma in each mouse. The appearance of carcinomata in the mice of the experimental group was earlier and the time of transition from papilloma to carcinoma was shorter when the mice had been treated with extracts. Although these small differences fall within the limits of probable error, a definite, constant trend toward earlier cancer in the extract-painted group is suggestive. Subsequent experimentation may show it to be significant.

Further evidence shows that the fundamental biology of the papilloma *per se* is not altered. One might expect a difference in the incidence of papillomata that subsequently became malignant with respect to the time at which they arose. If the proportion of carcinomata that arose from the first papilloma in each mouse is computed, it is found to be almost identical for the two groups (table 2). The second, third, and subsequent papillomata show considerable variation. If these are grouped together, however, the incidence of carcinomata arising from the papillomata is the same. The total incidence of

carcinomata arising from papillomata in control and experimental groups is 20.1 percent and 16.5 percent, respectively. The difference between the two proportions falls within the limits of experimental error.

TABLE 2.—*Incidence of carcinomata arising from papillomata with reference to sequence of appearance of papillomata*

Factor	Benzpyrene only				Extract and benzpyrene		
	Group A	Group B	Group C	Total	Group D	Group E	Total
Total number first papillomata	37	39	39	115	46	43	89
Number of carcinomata	11	13	17	41	15	16	31
Percent of carcinomata	30.0	23.3	43.5	35.6	32.6	38.1	34.8
Total number second papillomata	23	23	29	75	41	35	76
Number of carcinomata	0	5	6	11	8	10	18
Percent of carcinomata	0	21.7	20.6	14.6	19.5	28.5	23.6
Total number third papillomata	16	19	16	51	34	32	66
Number of carcinomata	2	2	3	7	2	4	6
Percent of carcinomata	12.5	10.5	18.8	13.7	5.8	12.5	9.1
Total number fourth papillomata	10	12	11	33	28	26	54
Number of carcinomata	0	0	0	0	4	1	5
Percent of carcinomata	0	0	0	0	14.3	3.9	9.2

The part played by the extract in the increase in tumor production is not clear. Baumann, Jacobi, and Rusch (*5*) noted that "animals on a high fat diet became greasy in appearance," suggesting that the action of the ration might have exerted itself locally. A group of 50 C57 black mice was injected twice weekly with 0.05 cc. of petroleum ether extract of mouse carcasses in the subcutaneous tissue of the inguinal region. This was continued for 14 weeks. The mice were painted in the interscapular region with 3:4-benzpyrene 0.5 percent in benzene 20 to 30 minutes after each injection. A second group of mice was treated in the same manner except that sesame oil (technical grade) was substituted for the extract. Another group received local applications of benzpyrene only (group B, table 1). The appearance of the coat was not changed. The results of the experiment are presented in table 3. No significant difference in production of benign or malignant skin tumors was found. The effect of larger subcutaneous doses of extract will be investigated.

Crystalline benzpyrene is soluble in petroleum ether extract of mouse carcasses to at least 0.5 percent. The oily nature of the extract might cause it to be absorbed slowly and leave enough on the skin to dissolve the benzpyrene in benzene that was applied later, and a prolonged action of benzpyrene on the skin might be obtained. Previous experience showed that benzpyrene dissolved in similarly prepared extract was not effective in the production of sarcomata when injected subcutaneously in C57 black mice (*8*).

TABLE 3.—*The effect of injection of sesame oil and petroleum ether extract of mouse carcasses on the production of skin tumors by 3:4-benzpyrene in C57 black mice*

Factor	Sesame oil	Extract
Papillomata		
Effective total	49	49
Total number of mice with papillomata	40	44
Percent of mice with papillomata	82.6	89.8
Total number of papillomata	135	142
Mean number per mouse	3.37±0.42	3.21±0.42
Coefficient of variation	0.623	0.685
Mean latent period (days)	83.1±3.4	78.7±3.9
Coefficient of variation	0.256	0.327
Mean transition time to carcinoma (days)	45	40
Carcinomata		
Effective total	47	47
Total number of mice with carcinoma	20	25
Percent of mice with carcinoma	42.5	53.2
Total number of carcinomata	23	29
Mean latent period (days)	138.7±4.5	124.1±4.2
Percent of papillomata that became malignant	17.2	20.4

The results of painting mice with benzpyrene 0.5 percent in mouse extract are shown in table 4. The marked decrease in tumor production suggests an entirely different action from that anticipated. The difference may be due either to physical or chemical phenomena. An attempt was made to isolate benzpyrene from the extract solution by the method of Berenblum and Kendal (*9*). The substance obtained gave an ultraviolet absorption spectrum identical with that of 3:4-benzpyrene. This suggests that solution of the benzpyrene in the extract that has been previously painted on the skin does not increase tumor production.

TABLE 4.—*The effect of painting C57 black mice with 3:4-benzpyrene 0.5 percent in petroleum ether extract of mouse carcasses on the production of skin tumors*

Factor	Benzpyrene in benzene	Benzpyrene in extract
Papillomata		
Effective total	50	47
Number of mice with papillomata	35	29
Percent of mice with papillomata	70	61.7
Total number of papillomata	99	48
Mean number per mouse	1.98±0.28	1.02±0.9
Coefficient of variation	0.723	0.647
Mean latent period (days)	92.2±3.9	101.4±5.0
Coefficient of variation	0.257	0.252
Mean transition time to carcinoma	46.6±5.3	37.0±4.1
Carcinomata		
Effective total	45	47
Number of mice with carcinoma	24	18
Percent of mice with carcinoma	53.3	38.2
Total number of carcinomata	25	20
Mean latent period (days)	147.1	146.1
Percent of papillomata that became malignant	25.7	41.6

SUMMARY

A petroleum ether extract of mouse carcasses increased the number of skin tumors produced by 3:4-benzpyrene when painted on the skin 20 to 30 minutes before the carcinogen was applied to the

same area. The increase in carcinomata paralleled the increase in papillomata.

Subcutaneous injection of extract at a distance from the site of application of benzpyrene did not affect tumor production.

A solution of benzpyrene in petroleum ether extract of mouse carcasses produced fewer skin tumors than did benzpyrene in benzene.

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BACTERIUM TULARENSE: ITS PERSISTENCE IN THE TISSUES OF THE ARGASID TICKS *ORNITHODOROS TURICATA* AND *O. PARKERI*[1]

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In a study of ticks of the genus *Ornithodoros* as potential vectors of various infectious agents, it has been found that viable *Bact. tularense* may persist in the tissues of *O. turicata* for at least 674 days and in those of *O. parkeri* for at least 701 days following an infective blood meal, but that these ticks do not transmit the organism during the process of feeding.

The ticks used in this study ingested blood from guinea pigs ill with tularaemia. They were subsequently tested at irregular intervals for transmission of *Bact. tularense* and for the persistence of this organism in the tissues. The former tests were made by permitting individual ticks to feed to repletion on test guinea pigs and to detach voluntarily; the latter were made by injecting saline suspensions of tick tissues subcutaneously.

The clinical symptoms and the specificity of gross lesions in the test guinea pigs were confirmed by the recovery of pure cultures of *Bact. tularense* which were agglutinated by specific rabbit serum.

[1] From the Rocky Mountain Laboratory, Hamilton, Mont., Division of Infectious Diseases, National Institute of Health.

O. turicata

Infective feedings.—On May 7, June 13, and June 19, 1937, 22, 7, and 20 ticks, respectively, in various developmental stages, engorged on infected guinea pigs.

Test feedings on guinea pigs.—In the group of 22 ticks there were 37 test feedings; in the group of 7 there were 17, and in the group of 20 there were 52. The earliest and latest test feedings (of ticks which proved positive when injected) were made 28 and 618 days, respectively, after the infective feeding. In no instance did the host guinea pig show any evidence of tularaemia.

Tests by injecting a saline suspension of tick tissues into guinea pigs.—Twelve ticks died and were not injected. One guinea pig died on the second day after tick-injection showing no evidence of tularaemia. The results of injection of the remaining 36 ticks are shown in table 1. The tick number, the number of days after the infective feeding, the total number of feedings, and the stage or sex of the tick when injected are shown.

TABLE 1.—*The persistence of Bact. tularense in the tissues of O. turicata*

Tick number	Injected, days after infective feeding	Injected, days after last feeding	Total test feedings	Stage or sex
Positive tests:				
1	0	0	0	Nymph.
30	0	0	0	Do.
2	10	10	0	Do.
3	22	22	0	Do.
4	40	12	1	Do.
8	60	60	0	Do.
7	96	96	0	Do.
48	104	48	1	Male.
5	117	19	2	Do.
14	158	56	1	Do.
47	198	73	2	Do.
40	263	140	2	Nymph.
18	276	27	1	Male.
26	412	143	4	Female.
33	507	449	1	Male.
11	647	45	4	Female.
41	667	49	5	Do.
35	674	56	5	Do.
Total			29	18
Negative tests:				
21	143	45	1	Male.
34	303	178	2	Do.
43	311	167	2	Nymph.
32	465	338	2	Do.
23	482	351	2	Female.
45	490	298	3	Do.
29	507	385	2	Nymph.
16	526	336	2	Male.
49	564	439	2	Do.
28	578	421	2	Nymph.
25	583	518	1	Male.
46	584	25	2	Female.
39	587	443	2	Male.
27	588	456	1	Do.
42	608	88	2	Female.
6	634	21	5	Do.
38	664	94	4	Do.
22	703	42	5	Do.
Total			42	18

Eighteen ticks (8 nymphs, 6 males, and 4 females), 50 percent of the ticks injected, produced typical tularaemia in guinea pigs. Ten of these were from group 1 (71 percent), 1 from group 2 (16⅔ percent), and 7 from group 3 (43 percent). The small percentage of infections recovered from group 2 might indicate a low original tick infection rate. However, the ticks of this group were injected relatively late in the experiment, viz, 412, 482, 507, 578, 583, and 508 days, respectively, following the infective feeding. Only the 412-day tick produced infection. In group 1, which had the highest percentage of positives, ticks injected 0, 10, 22, 40, 60, 96, 117, 158, 276, and 647 days, respectively, following the infective feeding each produced typical tularaemia, while ticks injected after 143, 526, 634, and 703 days, respectively, gave negative results. In group 3, ticks injected 0, 104, 198, 263, 507, 667, and 674 days, respectively, following the infective feeding were positive and those injected 303, 311, 465, 490, 564, 584, 587, 608, and 664 days, respectively, failed to produce the infection.

Attempts to recover Bact. tularense from progeny of female ticks (table 2).—These tests are divisible into 3 groups, viz, progeny from females that died and were not injected, from females "negative" when injected, and from females "positive" when injected. In the first group 526 larvae were tested by feeding and 454 by injection, 72 nymphs by feeding and 3 by injection, and 16 adults by both feeding and injection. In the second group 443 larvae were tested by feeding, 276 by injection, 166 nymphs by feeding, 4 by injection, and 26 adults by both feeding and injection. In the third group 183 larvae were tested by feeding, 106 by injection, 66 nymphs by feeding, and 14 by injection. None of the test guinea pigs showed evidence of infection.

TABLE 2.—*Tests of progeny of O. turicata that ingested infective blood*

Number of females	Larvae		Nymphs, first to fifth stages		Adults	
	Fed	Injected	Fed	Injected	Fed	Injected
	PROGENY TESTED FROM FEMALES THAT DIED AND WERE NOT INJECTED					
6	526	454	72	3	16	16
	PROGENY TESTED FROM FEMALES "NEGATIVE" WHEN INJECTED					
5	443	276	166	4	26	26
	PROGENY TESTED FROM FEMALES "POSITIVE" WHEN INJECTED					
4	183	106	66	14	----	----

NOTE.—None of the above progeny produced tularaemia by feeding or injection.

O. parkeri

Infective feedings.—On June 18, 1937, 4 late nymphs and on October 21, 1937, 21 first stage nymphs engorged on a guinea pig infected with *Bact. tularense.*

TABLE 3.—*The persistence of Bact. tularense in the tissues of O. parkeri*

Tick number	Injected, days after infective feeding	Injected, days after last feeding	Total test feedings	Stage or sex
Group 1:				
1	57	57	0	Nymph.
2	81	81	0	Do.
3	131	131	0	Do.
4	412	412	0	Do.
Group 2:				
7	138	46	2	Male.
17	339	54	2	Female.[1]
20	355	69	4	Do.
23	440	156	4	Do.
2	470	303	4	Do.
4	496	328	4	Do.
11	529	77	4	Do.
14	576	67	5	Do.
21	606	97	4	Do.
15	667	158	5	Do.
25	701	191	4	Do.
8	died	----------	5	Do.
12	died	----------	4	Do.
Total	----------	----------	52	----------

[1] With the exception of this female, all ticks produced typical tularaemia when injected.

Tests by feeding on guinea pigs.—In the first group there were no test feedings. In the second group a total of 52 such feedings failed to infect the host guinea pigs. Forty-one of these were by ticks which proved infective when injected. The earliest and latest test feedings (of ticks which proved positive when injected) were made 28 and 509 days, respectively, after the infective feedings.

Tests by injecting a saline suspension of tick tissues into guinea pigs.—Each of the first 4 ticks produced typical tularaemia when injected 57, 81, 131, and 412 days, respectively, following the infective feeding. Only 11 of the second group survived for injection. Ten of these were males and 1 a female. The latter failed to infect when injected 339 days following the infective feeding. The 10 males produced typical infections when injected at 138, 355, 440, 470, 496, 529, 576, 606, 667, and 701 days, respectively.

DISCUSSION

The residence of *Bact. tularense* in the two species of ticks does not adversely affect the virulence of the organism. Of the 18 guinea pigs that died of tularaemia following injection of infected *turicata,* 3 died on the second day, 6 on the third, 7 on the fourth, and 2 on the sixth day. The last 2 were 263- and 412-day ticks. The 674-day tick produced death in 2 days.

It is also shown that starvation of the tick does not affect the virulence of the organism. Although the 507-day tick had not received a blood meal for 449 days previous to injection, it produced death on the third day. The guinea pig which received the 412-day infected *parkeri* died on the third day. This tick had not fed during the 412-day period. The guinea pig which received the 701-day tick died on the fourth day. This tick had not fed for 190 days.

Kamil and Bilal (*1*), working in Turkey, have reported the transmission of *Bact. tularense* by *O. lahorensis.*

CONCLUSIONS

1. *Bact. tularense* may survive for at least 674 and 701 days, respectively, in the tissues of *Ornithodoros turicata* and *O. parkeri*, but is not transmitted during feeding.

2. The virulence of the organism was not adversely affected by the long period of residence in these ticks nor by the failure of the ticks to receive a blood meal.

REFERENCE

(*1*) Kamil, Server, and Bilal, Sait: Experimental research on the etiology of tularaemia in Turkey. Ann. de Parasit., **16**: 530–542 (1938).

TICKS (*ORNITHODOROS* SPP.) IN ARIZONA BAT "CAVES"[1]

By Cornelius B. Philip, *Medical Entomologist, United States Public Health Service*

Incident to studies of *Ornithodoros* ticks and relapsing fever being carried on by the Rocky Mountain Laboratory, several observations on ticks of this genus in association with bats were made in late September 1939, in Arizona. Of principal interest was the finding for the first time, under natural habitat conditions, of the recently described bat-guano tick, *O. coprophilus* McIntosh (1935). This tick previously had been collected only at Tucson, Ariz., from guano sold locally, and at Matamoros, Mexico, from bat fertilizer intended for importation at Brownsville, Tex.

Of the various types of roosts used by bats, mine tunnels with their easily reached ceilings and less irregular walls offered the most advantageous conditions for sampling both roosting bats and guano. (See also Stager, 1939.) Collections were made in four such tunnels. Males of the desert pallid bat, *Antrozous pallidus pallidus*, were obtained in one in the Santa Rita Mountains (September 21), and

[1] Contribution from the Rocky Mountain Laboratory, Hamilton, Mont., Division of Infectious Diseases, National Institute of Health. Read before the Columbus, Ohio, meeting of the American Society of Parasitologists, December 28, 1939.

females in one near Arivaca (September 22); a few of unrecorded sex were found in another in Picacho Mountain (September 24). A few *Myotis velifer velifer*, the cave bat, were found in a tunnel near Ruby and males were also present by the hundreds in the Picacho "cave." In the latter, both sexes of the Mexican free-tail, *Tadarida mexicana*, were present in immense numbers, and occasional specimens, predominantly males, of *Macrotus californicus*, a leaf-nose species.

Fifteen and 12 *A. pallidus*, respectively, taken in the Santa Rita and Arivaca caves, were infested by *talaje*-like larvae which have not yet been identified, but which are definitely not *O. coprophilus*. Most of these bats were infested by one or more ticks, and one from the Arivaca tunnel yielded 17 in various stages of engorgement. Only the nearly engorged larvae voluntarily detached from killed and bagged animals; the partially fed ticks had to be removed by excising the portions of the skin to which they were attached. Three more larvae, apparently of the same species, were taken from 2 of 45 bats collected in the Picacho "cave." Developmental studies of these specimens are being made by Dr. R. A. Cooley and Glen M. Kohls.

The Arivaca and Picacho "caves" were the only ones visited which were inhabited by sufficient numbers of bats to provide an appreciable accumulation of guano on the tunnel floors. No *O. coprophilus* were found in guano from the first, although the far end was not examined. This may have been an oversight in view of the Picacho experience recounted below.

The Picacho "cave" was a mine tunnel driven 310 feet into solid rock 5 years previously. The ceiling was only 6½ to 7 feet high and could easily be studied by flashlight. Guano was continuous over the floor, starting about 20 feet from the entrance, and samples taken up to approximately 260 feet inside revealed only tremendous numbers of dermestid beetles and pseudoscorpions. In the last 50 feet, however, the guano was found infested with *coprophilus* in increasing numbers and in the last 25 feet flashlight examination showed thousands of ticks crawling sluggishly over the surface. None was found below the surface or higher than 2 to 3 inches above it on the walls. A bagged sample of guano from an estimated surface area of one square foot and approximately 2 inches deep taken from near the end of the tunnel was found to contain 301 ticks in all stages from young nymphs to adults. The guano here was moist and sticky, its temperature being 81° F., identical with that of the air at arm's height. A sling psychrometer showed the relative humidity to be between 91 and 92 percent in this part of the tunnel. A very foul atmosphere, strongly ammoniated, discouraged prolonged observation.

Bats were hanging on the ceiling in countless numbers almost the full length of the tunnel. After those above the tick-infested guano were dislodged, no ticks could be found on the ceiling or upper walls. There were very few crevices and fissures in which they could have escaped notice. No *coprophilus* were found on 18 bats picked off the ceiling over the ticks, nor on 27 others taken on the wing, and none of the specimens of the various stages of this tick collected on the guano showed evidence of blood meals. Two dozen, representing the several stages present, were immediately placed in alcohol for later dissection. These also furnished no evidence of recent feeding.

Not knowing the parasitic proclivities of this species, but recalling the habits of other *Ornithodoros*, such as *turicata* in Texas caves, the writer was concerned about standing and walking in the midst of so tremendous a population of ticks, but at no time did any ticks attempt to crawl on to his shoes, and when placed thereon consistently crawled off. Later, on request, the owner of the property, Mr. L. O. Brown, confined live bats and fresh ticks of all stages in bags for several days, but when received at Hamilton none of the ticks showed evidence of having fed. Mr. Brown, using a mask to facilitate longer observation, observed ticks higher on the walls than any noted by the writer, but still found none on the bats or on the ceiling near them. In spite of present lack of evidence of tick parasitism of the bats, there was no evidence of use of the "cave" by other possible hosts.

In further guano samples forwarded by Mr. Brown, there were, in addition to very numerous *O. coprophilus*, 25 nymphs and 3 adults of a species obviously not *coprophilus* and also not of the same species as the larvae collected from bats. This will be described as a new species by Dr. Cooley and Mr. Kohls.

As thus far observed, it appears rather unlikely that *O. coprophilus* is an agent of disease transmission to man, or that its distribution with commercial bat fertilizer is potentially dangerous. However, its host habits and developmental requirements remain speculative. It is possible that, if *coprophilus* does parasitize bats, the relationship may be seasonal.

ACKNOWLEDGMENT

Special thanks are due Mr. L. O. Brown, owner of the Picacho property, for his cooperation and generous assistance in gathering materials, and to Dr. E. Raymond Hall and Mr. R. A. Flock who identified the bats.

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STUDIES ON TRICHINOSIS

VIII. THE ANTIGENIC PHASE OF TRICHINOSIS[1]

By JOHN BOZICEVICH, *Associate Zoologist*, and LASZLO DETRE,[2] *Senior Immunologist, National Institute of Health, United States Public Health Service*

This study evolved from the attempts of the writers to develop a test which could be used in diagnosing trichinosis at an earlier stage of the disease than has been possible heretofore. Serum from rabbits which had been fed trichinae 24 hours previously was injected into the skin of trichina-infected rats, the serum of which was known to contain precipitins. A wheal occurred at the site of injection, suggesting the presence of antigen in the rabbit serum since the type of reaction was unlike that given by the serum of noninfected rabbits. Further tests to determine the presence of antigen in rabbits recently infected with trichinae were made by injecting the serum of these rabbits into noninfected rabbits at a stage prior to the development of precipitins in the infected rabbits. It was found that precipitins developed in the rabbits which received the transferred serum; that these precipitins could be detected at an earlier stage than in those rabbits which received the trichinae; and that the period between the infection of rabbits in the primary group and the appearance of precipitins in rabbits of the secondary group was relatively constant. This phenomenon is not dependent upon the passive transfer of precipitins, since precipitins were not demonstrable in the blood serum of infected rabbits at the time of the transfer.

While a few previous investigators have made analogous observations in connection with other antigens and antibodies, their experiments have been either inconclusive or have resulted in contradictory findings.

Thus Detre [i. e., Deutsch] (*1*) inoculated killed typhoid bacilli into guinea pigs and transferred their serum to noninfected guinea pigs. Eight days after injection agglutinins appeared in the blood of the latter animals in a titer as high as 1:300.

Luckhardt and Becht (*2*) inoculated dogs with the emulsified spleen of other dogs which had been injected 24 hours previously either with goat corpuscles or with typhoid bacilli, and subsequently demonstrated corresponding antibodies in the recipients. However, with defibrinated blood, they could not demonstrate an increase in the agglutinin titer in the secondary animals.

Scarff (*3*), employing sheep cells and typhoid organisms as antigens, obtained results similar to those of Luckhardt and Becht.

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[1] From the Division of Zoology and the Division of Infectious Diseases.

[2] Died May 26, 1939.

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Rosenthal (*4*) injected colloidal phenolphthalein into guinea pigs and collected the blood from these animals 1½ hours later. This was inoculated into other guinea pigs. He found that some of the latter animals became sensitized to the colloidal phenolphthalein.

Manwaring, Marino, McCleave, and Boone (*5*) found that the blood from dogs which had received horse serum 4 days previously was capable of inducing anaphylactic shock in hypersensitive dogs. These authors showed that the antigenic property was not lost after a sojourn of 4 days in the circulation of the injected animals. However, in contradiction to these results, Hektoen and Carlson (*6*) concluded that antigens are quickly removed from the blood and the antigenic property lost. Topley (*7*) obtained indifferent results in this connection.

EXPERIMENTAL PROCEDURE

All experimental animals were checked for the possible presence of precipitins to trichina antigen before being placed in the experiments; however, none gave positive tests.

Several series of rabbits were infected with living trichina larvae, and, successively at daily intervals after infection, one of these animals, hereinafter called "donors," was bled from the heart and its serum injected intravenously into a noninfected rabbit, the noninfected rabbits hereinafter being called the "recipients."

For convenience, the time elapsing between infection and drawing of the blood from the donors will be called the first incubation period or the "antigenic phase." The time elapsing from the injection of the recipient animal with the serum from the donor to the appearance of demonstrable precipitins in the serum of the recipient will be called the second incubation period. An example of the procedure is as follows: Donor rabbit No. 3 (table 1) was given by stomach tube 6,600 larvae, or 3,000 larvae per kilogram of body weight. Twenty-four hours later, in order to obtain blood for the precipitin test, the animal was bled from the ear previous to anesthetization, since it was found that the serum became cloudy when etherization was employed. After the blood had been taken from the ear, the animal was immediately anesthetized and 50 to 80 cc. of blood drawn and distributed in large centrifuge tubes. The blood was allowed to stand until the clot retracted and was then centrifuged. The serum was decanted and examined under the microscope for the possible presence of migrating trichina larvae. Passive transfer of trichina larvae does not occur before the ninety-sixth hour after infection; however, after this period particular attention should be given to the serum in order to prevent the transfer of larvae. In these experiments larvae have never been found in the serum obtained after

clotting, but they have been observed enmeshed in the clot from blood drawn after the one hundred and twentieth hour.

Within 3 hours after drawing the blood from the donor, recipient rabbit No. 3A was injected intravenously with 10 cc. per kilogram of body weight of serum from donor No. 3. The total quantity of serum injected was 21.9 cc. Recipient No. 3A was bled from the ear daily thereafter and precipitin tests were performed on the serum. A positive precipitin reaction was obtained on the sixteenth day after this animal had received the serum injection, or 17 days after the date of infection of the donor animal. The length of the first incubation period, or the antigenic phase, was 1 day, and that of the second incubation period was 16 days.

Our experience is in agreement with that of Trawinski and Maternowska (*8*), who found that precipitins can usually be demonstrated in trichina-infected animals on and after the fourteenth day following infection. However, precipitins develop earlier at times, and it is therefore necessary to make daily tests on the infected or donor animals in order to avoid the actual transfer of precipitins to recipient animals.

METHOD OF PERFORMING PRECIPITIN TESTS

By means of a capillary pipette, 0.05 cc. of undiluted serum is placed carefully in the bottom of a 2 x 60 mm. tube. The tubes are centrifuged immediately in order to insure that the walls are free from serum. This precaution is important in order to obtain an accurate reading with the stratification method. Trichina antigen prepared according to the method of Bozicevich (*9*) in progressive dilutions of 1:20 to 1:320 is stratified in 0.05 cc. volumes over the centrifuged undiluted serum. Two controls are employed, one in which physiological saline is stratified over the experimental rabbit serum, and the other in which human serum in progressive dilution of 1:20 to 1:320 is stratified over the rabbit serum.

The tubes are read for the appearance of a precipitin ring at the end of 15 minutes, 30 minutes, 1 hour, and 2 hours. When the serum of anesthetized animals is injected into recipient animals, a pseudo-precipitin ring is often obtained 24 hours after injection. In such instances the serum should be diluted 1 to 1 and the test repeated. The use of diluted serum obviates the appearance of the pseudo-reaction. These pseudo-reactions are occasionally encountered in the early stages of natural infections with trichinae, and serum from such cases contains relatively large quantities of lipoid-like substances which render difficult the reading of the reaction. At times a double ring formation is seen. According to Schaefer (*10*) this is dependent upon the relative concentrations of the antigen

and antibody. Thus, the ring forms in the serum if the antigen is in excess, and in the antigen when the antibody is in excess.

EXPERIMENTAL RESULTS

Fifty-three recipient rabbits were used in our experiments. One of these died, 2 failed to develop precipitins, and 3 showed evidence of a passive transfer of precipitins. These 6 animals were discarded. Since the donor's serum was transferred to recipients within 3 hours after bleeding, and the 3-hour period was insufficient for conducting precipitin tests, they were performed on the following day. The

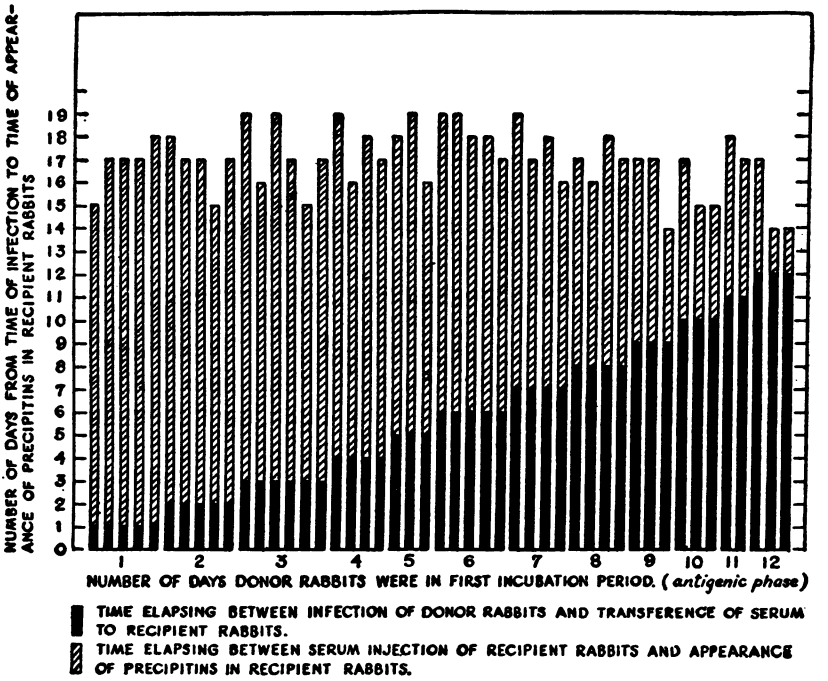

FIGURE 1.—Correlation between time of infection in donor rabbits and time of appearance of precipitins in recipient rabbits.

recipient rabbit was discarded if it appeared that precipitins had been transferred. The appearance of precipitins in 3 donors before the twelfth day (actually the ninth and tenth days) emphasizes the necessity of daily titration for precipitins in the donor's serum.

The donor rabbits were infected with larvae in numbers which varied from 3,440 to 24,792, or the equivalent of 990 to 9,000 larvae per kilogram of body weight. The recipient rabbits received the donors' serum in quantities which varied from 17.48 to 55.00 cc., or a dose equivalent to 10 to 24 cc. per kilogram of body weight.

Experiment A.—The results of the experiment are summarized in table 1. Although the average period required for the development of precipitins in donor rabbits after the feeding of trichina larvae was

14 days, it will be noted that precipitins developed in the recipient rabbits in 15 to 19 days (average 17 days), from the date of the original feeding of the donors. As shown in figure 1, there is a rather definite correlation between the period required for the development of precipitins in the recipient animals and the period of incubation in the infected or donor animals.

In view of the generally accepted opinion that the introduction of an antigen into the circulation is followed by its disappearance after varying intervals of time because of some interaction in antibody formation, it was expected that serum drawn from animals shortly

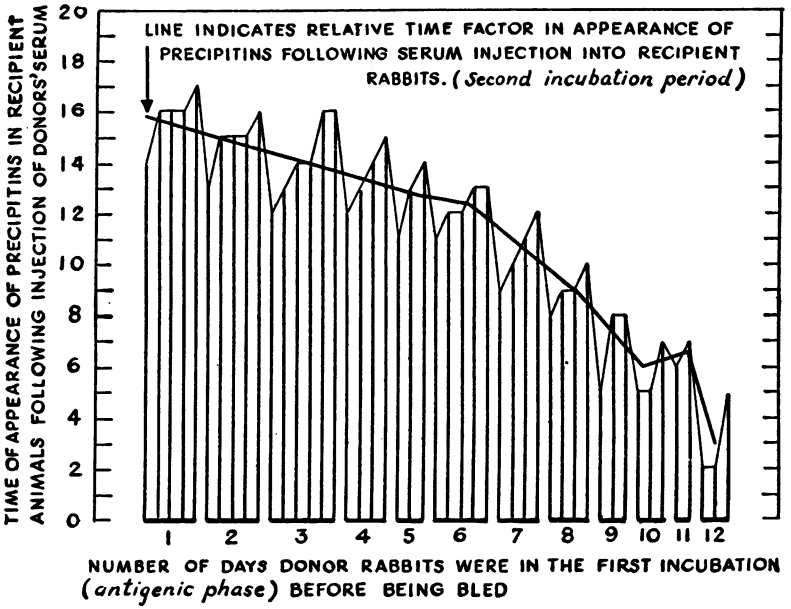

FIGURE 2.

after their infection would contain more antigenic constituents than that withdrawn at later periods. On the contrary, it was found that the introduction of the serum drawn in the later stages of infection was followed by a more rapid development of precipitins in the recipient rabbits. This accelerating characteristic of the donors' serum is shown in figure 2. Particular attention is called to the protocols of rabbits Nos. 23 to 53 in table 1. There would appear to be a modification of the antigen during its period of incubation in the infected donor animal so as to stimulate more rapidly the formation of precipitins in the recipient animal.

The question arises, however, as to whether this increased stimulating property of the antigen is actually due to its modification within the body of the infected animal or whether it is due to an increase in the amount or change in the quality of the antigen. In *Trichinella spiralis* infections, it will be remembered that two sources of antigen

are present. One source is represented by adult parasites located in the intestine of the host, the female worms at least having a longevity of 6 weeks or more, and the other source represented by the multiple broods of larvae which enter the systemic circulation and eventually come to rest in the voluntary muscles of the same host.

TABLE 1.—*The antigenic phase in donor rabbits infected with trichina larvae as demonstrated by the appearance of precipitins in noninfected rabbits injected with the blood serum of the donors*

Donor animals				Recipient animals				
Rabbit No.	Number of larvae fed		Number days infection to bleeding	Rabbit No.	Amount of donors' serum injected		Appearance of precipitins	
	Total	Per kilogram of body weight			Total	Per kilogram of body weight	Number of days from serum injection	Number of days from infection of donor
					Cc.	*Cc.*		
1	3,440	980	1	1A	30.00	10.00	14	15
2	3,750	1,530	1	2A	45.00	18.00	16	17
3	6,600	3,000	1	3A	21.90	10.00	16	17
4	11,910	6,000	1	4A	17.48	10.00	16	17
5	18,000	9,000	1	5A	22.95	10.00	17	18
6	3,750	1,290	2	6A	55.00	22.00	16	18
7	3,440	1,990	2	7A	30.00	13.00	15	17
8	7,209	3,000	2	8A	23.22	10.00	15	17
9	7,200	3,760	2	9A	30.00	12.90	13	15
10	11,160	6,000	2	10A	23.45	10.00	15	17
11	5,700	2,500	3	11A	30.00	13.00	13	16
12	3,750	3,000	3	12A	37.00	14.00	16	19
13	6,777	3,000	3	13A	19.45	10.00	16	19
14	9,000	3,770	3	14A	30.00	13.00	14	17
15	7,200	3,950	3	15A	30.00	16.00	12	15
16	11,240	6,000	3	16A	24.21	10.00	14	17
17	3,750	1,390	4	17A	33.00	15.00	15	19
18	5,475	3,000	4	18A	18.50	10.00	12	16
19	12,630	6,000	4	19A	21.44	10.00	14	18
20	16,560	9,000	4	20A	18.30	10.00	13	17
21	3,750	1,323	5	21A	42.00	19.00	13	18
22	6,567	3,000	5	22A	20.20	10.00	14	19
23	22,874	6,000	5	23A	23.65	10.00	11	16
24	3,750	1,360	6	24A	40.00	17.00	13	19
25 [1]			6	25A	50.00	17.00	13	19
26	4,892	3,000	6	26A	22.14	10.00	12	18
27	24,792	6,000	6	27A	22.85	10.00	12	18
28	18,252	9,000	6	28A	22.63	10.00	11	17
29 [1]			7	[2] 29A			12	19
30	3,750	1,470	7	30A	40.00	16.00	10	17
31	11,179	3,000	7	31A	20.00	10.00	[3]	
32	12,000	6,000	7	32A	20.10	10.00	11	18
33	19,764	9,000	7	33A	20.75	10.00	9	16
34	3,750	1,260	8	34A	42.00	10.00	9	17
35	10,548	3,000	8	35A	22.15	10.00	8	16
36	6,186	3,000	8	36A	22.35	10.00	[4]	[4]
37	12,258	6,000	8	37A	21.90	10.00	10	18
38	17,325	9,000	8	38A	21.75	10.00	9	17
39 [1]			9	39A	28.00	9.00	8	17
40	3,750	1,370	9	40A	40.00	17.00	8	17
41	6,528	3,000	9	41A	19.50	10.00	5	14
42	13,632	6,000	9	42A	19.16	10.00	[5]	[5]
43 [1]			10	43A	35.00	10.00	[5]	[5]
44	3,750	1,410	10	44A	40.00	24.00	7	17
45	7,197	3,000	10	45A	19.25	10.00	5	15
46	13,560	6,000	10	46A	20.50	10.00	5	15
47	17,280	9,000	10	47A	22.85	10.00	[5]	[5]
48 [1]			11	48A	47.00	13.00	7	18
49	3,750	1,390	11	49A	32.00	15.00	6	17
50 [1]			12	50A	33.00	11.00	5	17
51	3,750	1,240	12	51A	50.00	22.00	[6]	[6]
52	6,135	3,000	12	52A	19.90	10.00	2	14
53	12,486	6,000	12	53A	19.10	10.00	2	14

[1] Some larvae were lost during administration; for this reason, no accurate determination of the dosage could be made. [2] Part of the serum was inadvertently lost during administration.
[3] Died. [4] Did not appear. [5] Passive transfer.

A second experiment (B) was performed in order to determine whether any increase occurred in the amount of antigen. The previous procedure was duplicated except that instead of infecting the donor rabbits with living trichina larvae each animal received a single injection of an antigen consisting of an extract of dried pulverized trichina larvae. Under these conditions it was assumed that no multiplication of the antigen could take place in the donor rabbits.

Experiment B.—Five rabbits were injected with a 1:20 dilution of the dried antigen in doses of 1 cc. per kilogram of body weight, and 2 to 5 days later were bled from the heart. The collected serum was injected into a second series of nontreated rabbits in quantities equal to 10 cc. per kilogram of body weight. Tests were made daily for the detection of precipitins in each animal of the two groups. The protocols of the experiment are given in table 2. It will be seen that precipitins developed in the donor animals in 4 to 5 days and in the recipient animals from 3 to 6 days, the total incubation period in both donors and recipients being from 6 to 11 days.

TABLE 2.—*Appearance of precipitins following injection of donor rabbits with a 1:20 dilution of an extract of dried trichina larvae as an antigen and the transfer of the donors' serum to recipient rabbits*

Donor animals				Recipient animals				
Rabbit No.	Amount of extract injected	Appearance of precipitins following injection (days)	Titer of precipitins	Rabbit No.	Incubation period of donors' serum injected (days)	Amount of serum injected	Appearance of precipitins following serum transfer (days)	Titer of precipitins
	Cc.					*Cc.*		
1	2.12	4	1:80	1A	2	18.85	4	1:160
2	2.57	5	1:160	2A	3	19.00	4	1:40
3	2.39	4	1:160	3A	4	19.15	[1] 3	1:160
4	2.07	4	1:80	4A	4	19.10	[1] 3	1:160
5	2.31	5	1:80	5A	5	19.75	[1] 6	1:20

[1] Passive transfer of precipitins occurred as evidenced by precipitin titers of 1:40, 1:12, and 1:12, respectively, 24 hours after injection.

Serum from 3 donor rabbits, Nos. 3, 4, and 5, gave precipitin titers of 1:160, 1:80, and 1:80, respectively, on the day that serum from these animals was transferred to recipient rabbits Nos. 3A, 4A, and 5A. Precipitin tests on the serum of these latter rabbits on the following day gave titers of 1:40, 1:12, and 1:12, respectively. However, precipitins could not be detected in the blood serum of these recipient rabbits at the forty-eighth hour after injection of the donors' serum. Precipitins reappeared at the seventy-second hour after injection in rabbits 3A and 4A when the titers obtained were higher than those found at the twenty-fourth hour.

Precipitins persisted from 9 days to 2 months following their appearance in 4 of the recipient rabbits (table 2). In the fifth animal

(1A), they were still present on the fifth day but were not present 2 weeks later when an additional test was made. Under the conditions of the experiment, the persistence of precipitins over the above-mentioned period would seem to furnish additional evidence against the passive transfer of appreciable quantities of precipitins.

The use of a larger number of animals in experiment B, and the continuation of the experiment over the same period of time as in experiment A, would no doubt have added emphasis to the results obtained. However, relatively large quantities of trichina antigen would have been needed and such quantities were not available because of the demand for the antigen for diagnostic purposes.

Regardless of the limitations of the experiment, the findings would seem to indicate that there had been some modification of the antigen which was transferred in the serum of the donor rabbits. Experiment A has since been duplicated, with human blood serum used as an antigen. The results, which will be published elsewhere, confirm the conclusions made in regard to experiment B.

DISCUSSION

The results of these experiments (experiment B) show that trichina antigen is not lost from the sera of inoculated animals within 5 days after its introduction. Following the feeding of trichina larvae (experiment A) it was not lost within 12 days. This is contrary to the generally accepted opinion that antigen disappears rapidly after its introduction into the animal because of excretion, denaturation, or its interaction in antibody formation.

The question arises as to whether the antibody production in recipient animals was due to progressive development of antigen in the larvae-infected animals, a quantitative factor, or whether it was the result of a change in the quality or character of the antigen.

In this connection no relation was found between the number of larvae fed or the dose of serum transferred and the time required for development of precipitins. In the few animals injected with the same dosage of antigen on a weight basis there was no uniformity in the time of appearance of precipitins. Since there is no migration of larvae from the intestine within 4 days after the feeding, it is evident that there could have been no increase of antigen because of larvae invasion during this period. Nevertheless, the relationship between the length of the antigenic phase in the donor animals and that of precipitin formation in the recipient animals remained unchanged. It may appear that the longer antigenic phase may be marked by the presence of a greater amount of antigen in the serum and thus result in the production in the recipient animals of an

earlier precipitin response. Kahn (*11*), on the other hand, believes that an animal will develop immunity responses more quickly to smaller doses of antigen than to greater quantities. Again, the number of larvae given any one animal may not bear any relation to its reaction in either the production of antigen or antibodies or in its susceptibility to infection, since animals vary in their individual response to dosage of equal quantities.

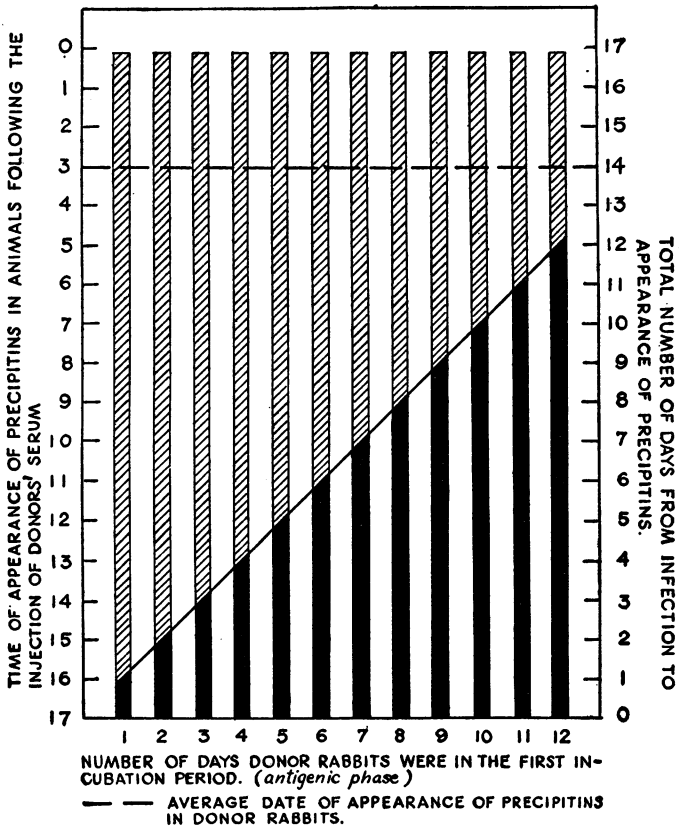

FIGURE 3.—Schematic diagram showing correlations of average time of infection in donor rabbits and average time of appearance of precipitins in recipient rabbits.

While these experiments do not offer conclusive evidence against the possibility of quantitative factors in the speed of production of precipitins, the rather consistent inverse relationship between the length of the first incubation period and that of the second incubation period together with the constancy of the total period for precipitin production suggests that the antigen is modified in proportion to the length of time it is in the serum of the original donor animal. This inverse relationship is illustrated schematically in figure 3.

There seems to be ample evidence that the reactions in the recipient animals were not due to the transfer of precipitins because, aside from the technical exclusion of the latter, the animals receiving the serum later responded to a second antigen stimulation similar to that occurring in animals actively immunized.

SUMMARY

Antigens have been demonstrated in rabbits as early as 24 hours after the feeding of trichina larvae. The presence and persistence of these antigens in the serum for several days previous to the active development of precipitins has been shown by the injection of their serum into other noninfected rabbits, with the subsequent development of precipitins in the latter. This period of antigen circulation has been referred to as the antigenic phase. The length of the antigenic phase bears a relationship to the speed of production of precipitins in the recipient animals. The total period between the infection of the primary animal and the appearance of precipitins in the recipient animal is relatively constant. The possible bearing which both quantitative and qualitative factors may have in connection with these results is discussed.

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THE OCCURRENCE OF *ANOPHELES DARLINGI* ROOT IN BRITISH HONDURAS AND GUATEMALA

By W. H. W. Komp, *Senior Medical Entomologist, United States Public Health Service*

In October and November 1939, Mr. Ivan Sanderson of the British Museum made several collections of mosquitoes at his camp on Dog Creek, at the base of the foothills just south of Stann Creek, in British Honduras. The specimens were sent to the writer for identification by Dr. R. L. Cheverton, senior medical officer, at Belize, British Honduras. Among the material were 9 adult specimens of an Anopheline mosquito tentatively identified as *Anopheles argyritarsis* R.-D. Fortunately, a single male was present in the series, and dissection and examination of the male terminalia showed that it was in every respect like the males of *Anopheles darlingi* Root collected previously by the writer in Venezuela and British Guiana.

Anopheles darlingi is the most dangerous vector of malaria in Brazil (except the imported *A. gambiae*) and in British Guiana and Venezuela. In Belem, Para, Brazil, Davis (*1*) found 22 percent of 220 dissected specimens to be infected. Davis and Kumm (*2*) dissected 240 specimens at França, Bahia, Brazil, and found 28.7 percent infected. At Itapira, Bahia, Brazil, Kumm (*3*) found 3 out of 5 specimens infected. Shannon (*4*) found 9 percent infected at Porto Velho, Amazonas, Brazil. This mosquito has also been reported by Bennaroch (*5*) as naturally infected in Venezuela. In Panama and elsewhere, the principal Anopheline vector of malaria, *Anopheles albimanus* Wied., has been found naturally infected in percentages ranging from 1 to 2.5 percent. The superior ability of *A. darlingi* as a vector of malaria is evident from these figures.

The northern range of *A. darlingi* has hitherto been considered as British Guiana and Venezuela, with one or two unconfirmed records from Colombia. It is not known from Panama or Costa Rica, or any of the other Central American countries. Its occurrence as far north as British Honduras was entirely unexpected, and because of its proved dangerous abilities as a malaria vector in South America an attempt to verify its presence in British Honduras was deemed advisable. Accordingly, the writer visited British Honduras, and in company with Dr. Vernon Anderson of the Department of Health went to the locality where the adults of *A. darlingi* had previously been found. On March 18, 1940, larvae and pupae corresponding in every respect to the published descriptions of the species (*6*), and to specimens in the writer's collection from South America, were found in side pools along Silk Grass Creek, about 200 yards from the camp of the Silk Grass Forest Reserve, which is about 2 miles from Sanderson's camp on Dog Creek. Later, larvae were found in small numbers,

but widely distributed, in pools along Silk Grass Creek below Silk Grass camp. Seven female adults, all blood-gorged, were taken in bed nets of the camp personnel and in the partly screened sleeping quarters of the party, and one female was captured attempting to bite. None were taken with horse bait.

Most of British Honduras was suffering from a severe drought, the dry season having been unusually severe. Many potential breeding places of *A. darlingi* were noted in and about the camp at Silk Grass Reserve. No specimens of larvae or adults were taken at Stann Creek Village, although *A. albimanus* was breeding freely in the lagoon behind the town.

The occurrence of *A. darlingi* elsewhere in the region is very probable. Through the courtesy of Dr. J. R. de Leon and Dr. Julio Herrera of the Departamento de Sanidad of Guatemala, the writer was permitted to examine their collections of mosquitoes from Guatemala. A series of 6 female specimens labeled "*albitarsis*?" and collected at Panzos, Guatemala, was found in the collections. Panzos is a town of some 3,000 situated about 50 kilometers west of El Estor, on the Rio Polochic above its entrance into Lago de Izabal (Golfo Dulce) and some 80 miles west of Puerto Barrios, on the Atlantic coast of Guatemala. These females lacked the two lines of white scales on the first abdominal sternite, characteristic of *A. albitarsis* L. Arrib., and differed in color markings from the specimens of *A. argyritarsis* R.-D. as found in Guatemala. They resembled in every respect the female *darlingi* collected by the writer at Silk Grass camp in British Honduras. It is therefore extremely probable that *A. darlingi* is present over a wide area of the neighboring coastal lowlands.

The larval and adult specimens from British Honduras, and 2 females from Panzos, Guatemala, were submitted to Dr. H. W. Kumm, who has had extensive experience with *A. darlingi* in Brazil. He confirmed the writer's identification of the material as *A. darlingi*.

The occurrence of *A. darlingi* so far north of its usual range is unexplained, and its distribution should be further investigated in view of its dangerous powers as a carrier of malaria. A full account of the conditions under which *A. darlingi* was found in British Honduras will be published elsewhere.

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SOME STATE LEGISLATION IN 1939 AFFECTING PUBLIC HEALTH

A summary of the more important State legislation of interest to physicians, enacted or proposed in 1939, appeared in the Journal of the American Medical Association for March 9, 1940 (pp. 875–889),[1] two sections of which relate to (1) health insurance, medical and hospital service plans, and care for the indigent sick, and (2) additional measures for the control of certain communicable diseases.

COMPULSORY AND VOLUNTARY HEALTH INSURANCE

Bills providing for some type of compulsory and voluntary health insurance failed of enactment in California, Connecticut, Massachusetts, New York, Pennsylvania, Rhode Island, and Wisconsin. In most of the bills, certain persons were excluded from the compulsory feature but were entitled to voluntary participation.

The life of the committee authorized by New York laws, 1938, to investigate health requirements and recommend health insurance proposals was extended to March 15, 1940; but bills to create similar commissions failed in Connecticut and Ohio.

VOLUNTARY MEDICAL SERVICE PLANS

Laws were enacted in Connecticut, Michigan, New York, Pennsylvania, and Vermont permitting nonprofit corporations which are so authorized by a designated State agency to operate, on a prepayment basis, nonprofit medical service plans whereby stated medical services can be rendered to subscribers. With some exceptions, these plans provide, in general, that the subscribers may have the services of physicians of their own choice and that the corporation is to pay the bills. Laws were enacted in Missouri and Arkansas permitting designated groups to provide medical and hospital services for their members.

Similar bills failed of enactment in California, Illinois, Ohio, Utah, Washington, and Wisconsin, and bills authorizing such plans for osteopathic care failed in Michigan and Pennsylvania.

VOLUNTARY HOSPITAL SERVICE PLANS

Laws authorizing the formation of nonprofit corporations to provide, on a prepayment basis, hospital care to their members or subscribers were enacted in Alabama, Connecticut, Florida, Iowa, Maine, Michigan, New Hampshire, New Mexico, Ohio, Rhode Island, South Carolina, Texas, Vermont, and Wisconsin.

[1] Legislation of Interest to Physicians Considered by State Legislatures in 1939. Prepared by T. V. McDavitt, of the Bureau of Legal Medicine and Legislation, American Medical Association.

Similar bills failed of enactment in nine States, and attempts to legalize like activities of organizations already operating hospital service plans were unsuccessful in two States.

Maryland adopted a resolution requesting the Governor to appoint a commission to study the question of compulsory hospital insurance, the prior California nonprofit hospital service plan law was amended, extending the scope and definition of "hospital services," and the Massachusetts nonprofit hospital service plan law was amended to require the State commissioner of insurance to approve contracts issued and rates charged by the hospital service plan corporation.

FREE CARE OF THE INDIGENT SICK OR THE GENERAL PUBLIC

A new Michigan law requires the several counties to provide for the rendering of medical care to indigents, defines the service, and provides for the maintenance of the private physician-patient relationship. A new Indiana law provides for care, in certain cases, by any hospital operated by the trustees of the Indiana State University, the cost to be borne by the county from which the patient is committed. Four States (Delaware, Florida, North Carolina, and South Carolina) passed laws authorizing specified counties to levy taxes to be used for medical and hospital treatment of the indigent sick.

Bills regarding State-wide plans for medical care failed of enactment in New York and California.

SPECIAL TREATMENT AND CONTROL OF DISEASE

Laws were enacted in Connecticut, Illinois, Indiana, and New Jersey appropriating money to the State board or department of health for the purchase and free distribution of pneumococcus serum for the treatment of persons afflicted with pneumonia and financially unable to purchase the serum. The Indiana laws authorize the distribution also of diphtheria toxoid, smallpox virus, and typhoid bacterins. A Florida law appropriated $10,000 to the State board of health for the purchase and distribution of insulin to persons needing it and financially unable to purchase it. A somewhat similar bill failed of passage in Wisconsin. A new Connecticut law authorized the State department of health to furnish such treatment to indigent typhoid or paratyphoid fever germ carriers as may be necessary to relieve them of the carrier state. A Pennyslvania bill authorizing the department of welfare to supply hearing aids or devices to needy persons unable to purchase them was killed, as were two New York bills regarding care and appliances in poliomyelitis, and two other bills imposing on counties or other political subdivisions the duty of supplying needed "physical repair" to physically handicapped unemployed adult persons and requiring the State to reimburse the local political subdivision by 75 percent of the total expended by them for such purpose.

Premarital examinations.—In the control of venereal diseases, laws requiring premarital examinations for syphilis were enacted in California, Colorado, Indiana, North Carolina, North Dakota, Pennsylvania, South Dakota, Tennessee, and West Virginia. The North Carolina and Tennessee laws relate to all venereal diseases. Proposals to condition the issuance of a license to marry on the presentation, by both parties to the proposed marriage, of a physician's certificate as to freedom from an infectious stage of a stated venereal disease were rejected in 16 other States.

Existing laws requiring premarital examinations were amended in Illinois, Michigan, and New York.

Blood tests of pregnant women.—Laws requiring the submission of blood specimens of pregnant women were enacted in California, Colorado, Delaware, Illinois, Indiana, Iowa, Maine, Massachusetts, Michigan, North Carolina, Oklahoma, Pennsylvania, South Dakota, and Washington. Similar bills failed in six other States.

Reporting.—A new Alabama law requires a physician, hospital, dispensary, or penal or other institution to report immediately to the county health officer a case of syphilis, gonorrhea, chancroid, venereal lymphogranuloma, or granuloma venereum. A similar bill failed in New Jersey.

Compulsory treatment.—An Alabama law authorizes the county health officer to require all persons infected with a venereal disease to undergo treatment by a licensed physician, such treatment to be at public expense if a patient is unable to pay.

Free treatment for indigents.—A Florida law authorizes counties of certain populations to provide medical treatment at county expense for all indigent residents suffering from venereal disease.

State facilities for diagnosis.—A new Oregon law amends a prior law. The prior law directed the State board of health to provide free facilities for laboratory examinations for diagnosing venereal disease and to provide the necessary materials for treatment to persons whom the attending physician certifies are unable to pay therefor. The amendment requires, as a condition precedent to supplying such services and materials, that the attending physician certify that he will make no charge to the patient for the treatment of the disease for which the test is made. In Florida and Utah, bills were killed which provided for free distribution of antisyphilitic drugs to persons unable to pay; and an Indiana bill, requiring the submission of blood samples for serologic test every 2 years by all physicians, dentists, and nurses, failed of enactment.

Appropriation for eradication of venereal diseases.—A new Colorado law appropriated $12,000 to the State board of health for the period

ending June 30, 1941, to be used for venereal disease control work. A bill in Texas, appropriating $150,000 to the State department of health for similar work, failed of enactment.

FOOD HANDLERS

A new Texas law prohibits the employment in any public eating or sleeping place, or place where food, drink, or candy is prepared or stored, of any person having an infectious or contagious disease. Such employees must present a physician's certificate every 6 months. Similar bills failed in five States.

DIPHTHERIA IMMUNIZATION

A compulsory diphtheria immunization law for children up to 5 years of age was passed in North Carolina, the county health officer to administer the prophylactic free of charge if the parents or guardians are financially unable to pay. A New Jersey law authorizes any board of education to condition school attendance on proof of immunity to diphtheria. Such board may provide, free of cost, materials and services for the required immunization.

CANCER

Laws directed at the control of cancer were enacted in four States. In Illinois, a division of cancer control was created in the State department of health, the receipt and expenditure of voluntary contributions were authorized, and an appropriation of $25,400 was made for the establishment of a cancer diagnostic service. In Wisconsin, provision was made for an annual appropriation of $10,000 for cancer research. A South Carolina law authorizes the State board of health to establish standards for cancer units in general hospitals, to provide financial aid for indigent cancer patients in such cancer units, to establish the necessary facilities for the treatment and cure of cancer patients, and to conduct educational programs. In Vermont, a State cancer commission was created which was authorized to establish and conduct cancer clinics in the State to care for indigent cancer patients and to grant aid to patients who are not wholly indigent but who cannot provide adequate care for themselves. An appropriation of $10,000 was made to the commission for each of the next 2 years.

EXAMINATION OF PUBLIC SCHOOL PUPILS AND EMPLOYEES

A New Jersey law requires local boards of education to determine the presence of tuberculosis in communicable form in the pupils under their jurisdiction. Any pupil found to have tuberculosis in a communicable stage must be excluded, and can be readmitted only when free from the disease in a communicable stage, when physically competent to engage in school activities, and when no longer a menace to the health of other pupils. Another law in New Jersey provides

that, in conducting the examinations required by law, the medical inspector may require pupils to loosen, open, or remove their clothing above the waist, provided the parents or guardians are notified and the examination is conducted in their presence or in the presence of a nurse or teacher. Still another New Jersey law authorizes boards of education to require a physical examination of all employees of the board at least once in 3 years. In case of mental abnormality or a communicable disease, the employee is ineligible for further service until proof of recovery is furnished.

Unsuccessful attempts were made in 3 States to require all public school teachers to undergo annual physical examinations and to submit to blood tests for tuberculosis and venereal disease.

BUREAUS OR DIVISIONS OF INDUSTRIAL HYGIENE

Idaho and Montana enacted laws establishing a bureau or division of industrial hygiene in the department of public welfare and State board of health, respectively.

Citations to these laws are given by Mr. McDavitt, who also discusses State legislation in 1939 relating to drugs, foods, cosmetics, and therapeutic devices, and to licenses for the practice of the healing art.

DR. W. H. SEBRELL WINS AWARD FOR VITAMIN B STUDIES

An honor for achievement in nutritional research has recently been conferred on Surg. W. H. Sebrell, of the United States Public Health Service, who shares the Mead Johnson & Co. award for "the most outstanding work on vitamin B complex in North America" in 1939. This honor, which carries a pecuniary award of $1,000, is shared equally between Doctor Sebrell and a group of five workers at the laboratories of Merck & Co., Rahway, N. J., and was bestowed in recognition of research on riboflavin deficiency in man.

In Dr. Sebrell's work, which was first reported in a preliminary note published in the Public Health Reports for December 30, 1938, and more fully presented in the issue of December 1, 1939, the condition caused by riboflavin deficiency was identified and described and methods of prevention and treatment were demonstrated.

The presentation of the award was made, on behalf of the award committee, by Dr. E. V. McCollum, of the School of Hygiene, Johns Hopkins University, at the meeting of the American Institute of Nutrition in New Orleans, La., on March 13, 1940.

The vitamin B awards are being presented annually over a period of 5 years by the Mead Johnson & Co., of Evansville, Ind. The first award was made in 1939, to Dr. C. A. Elvehjem, of the University of Wisconsin, for his discovery in connection with the use of nicotinic acid in the prevention of pellagra.

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COURT DECISION ON PUBLIC HEALTH

Pneumonia held not to result from "accident" within meaning of workmen's compensation act.—(Pennsylvania Supreme Court; *Parks* v. *Miller Printing Mach. Co. et al.*, 9 A.2d 742; decided December 4, 1939; rehearing denied December 29, 1939.) Recovery of compensation under the workmen's compensation act was sought for the death of an employee from pneumonia. Because of a flood the machinery in the employer's plant became covered with mud and dirt. After the waters had receded the regular employees, including decedent, were directed to clean their machines. The decedent started on this work about a week after the flood had occurred but the floors were still damp and muddy. After working for about 8 days he became ill with pneumonia, which was attributed by the attending physician to the conditions under which the decedent had been working. The decedent's death occurred shortly thereafter as a result of the pneumonia. The supreme court denied compensation on the ground that there had been no "accident" within the meaning of the workmen's compensation act. In the course of the opinion the court said:

* * * While, in the present case, it was the flood which made necessary the cleaning of the machinery, this operation was a protracted labor, and those who engaged in it voluntarily and deliberately exposed themselves to the dampness which they knew existed. Decedent worked for 8 days before he became ill, returning to the job each day in the usual fashion. Nor can the surrounding conditions during that time be fairly characterized as extraordinary. There was no sudden, intense exposure to water or to cold. The most that can be said is that there was dampness in the plant and mud on the floors as lingering effects of the flood. * * *

DEATHS DURING WEEK ENDED MARCH 30, 1940

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

	Week ended Mar. 30, 1940	Corresponding week, 1939
Data from 88 large cities of the United States:		
Total deaths	9,081	9,274
Average for 3 prior years	9,075	
Total deaths, first 13 weeks of year	123,083	123,277
Deaths under 1 year of age	514	553
Average for 3 prior years	573	
Deaths under 1 year of age, first 13 weeks of year	6,712	7,220
Data from industrial insurance companies:		
Policies in force	65,901,954	67,699,350
Number of death claims	13,732	17,021
Death claims per 1,000 policies in force, annual rate	10.9	13.1
Death claims per 1,000 policies, first 13 weeks of year, annual rate	10.7	11.3

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

REPORTS FROM STATES FOR WEEK ENDED APRIL 13, 1940

Summary

Reports received from the State health officers for the week ended April 13, 1940, indicate little change from the preceding week with respect to the 9 important communicable diseases included in the following weekly table. The incidence of each of these diseases for the current week is below the 5-year median expectancy based on the years 1935–39, is lower than for the preceding week for influenza, meningococcus meningitis, poliomyelitis, and scarlet fever (diphtheria approximately the same), and lower than for the corresponding week last year for all but scarlet fever and whooping cough. The cumulative totals for the first 15 weeks ending with the current week are below the 5-year (1935–39) median expectancy for all of these diseases except influenza and poliomyelitis.

As compared with 1938, the year with the record low general mortality rate for the United States, health conditions so far this year have been almost equally as good as interpreted by the incidence of most of the important communicable diseases. However, more than four times as many cases of influenza have been reported this year as in the same period in 1938, and the general weekly mortality in large cities reported by the Bureau of the Census has remained consistently above that for the corresponding period of 1938.

For the current week 72 cases of smallpox were reported, of which 18 occurred in Colorado and 19 in Iowa. For the preceding week 47 cases were reported—11 in Iowa, 5 in Illinois, and 4 in Colorado. Eleven cases of endemic typhus fever were reported, 6 cases of undulant fever (brucellosis), and 4 cases of Rocky Mountain spotted fever in western States.

Telegraphic morbidity reports from State health officers for the week ended April 13, 1940, and comparison with corresponding week of 1939 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none were reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39
	Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939	
NEW ENG.												
Maine	1	2	2	2	157	19	533	15	114	0	0	0
New Hampshire	0	0	0				93	17	18	0	0	0
Vermont	0	1	1				6	48	48	0	0	0
Massachusetts	6	3	6				604	1,032	714	0	1	2
Rhode Island	2	1	1				156	51	75	0	0	1
Connecticut	1	0	3	5	16	7	89	821	517	1	0	0
MID. ATL.												
New York	11	30	34	[1]14	[1]27	[1]14	641	1,839	2,842	4	3	10
New Jersey	5	9	14	10	13	9	533	57	977	0	0	2
Pennsylvania	25	23	33				211	139	863	8	16	10
E. NO. CEN.												
Ohio	11	15	17	78		26	27	25	900	0	0	14
Indiana	2	6	11	24	99	30	5	26	203	0	2	2
Illinois	17	33	30	13	57	35	92	26	209	1	1	8
Michigan [2]	3	12	11	25	15	7	464	324	324	0	3	4
Wisconsin	0	0	3	134	154	60	463	581	581	0	1	1
W. NO. CEN.												
Minnesota	2	1	2	3	2	1	178	754	239	0	0	1
Iowa	9	16	10	9	18	2	370	282	196	0	0	2
Missouri	5	3	15		18	103	71	14	31	3	1	1
North Dakota	3	1	1	28	38	13	10	26	26	0	1	0
South Dakota	3	10	2		12		9	239	0	0	0	0
Nebraska	0	9	3		14	1	24	67	70	0	0	1
Kansas	4	4	8	21	28	18	597	47	47	2	0	1
SO. ATL.												
Delaware	0	0	0				1	3	13	0	0	0
Maryland [2]	1	2	6	11	24	9	8	440	247	1	1	4
Dist. of Col.	2	4	4		2	1	3	200	68	0	0	3
Virginia	13	9	10	328	385		102	486	668	2	0	10
West Virginia [2]	10	5	9	59	238	69	18	8	61	4	2	6
North Carolina	12	12	15	14	43	43	177	538	253	0	0	2
South Carolina	11	8	4	442	893	331	27	48	42	0	0	0
Georgia [3]	10	6	7	94	763	201	89	155	0	0	0	1
Florida [2]	3	4	4	7	9	2	127	95	82	0	0	3
E. SO. CEN.												
Kentucky	2	9	11	10	79	34	93	28	315	0	2	7
Tennessee [2]	4	5	6	96	296	154	145	62	69	1	0	2
Alabama [3]	9	12	10	142	697	365	144	134	134	4	0	3
Mississippi [2]	5	4	5							1	0	2
W. SO. CEN.												
Arkansas	7	4	4	99	280	82	24	62	62	0	1	1
Louisiana	9	16	13	25	85	85	5	198	62	1	1	1
Oklahoma	5	7	7	171	179	133	18	292	146	1	2	3
Texas [3]	17	12	36	641	1,007	646	882	395	483	0	2	6
MOUNTAIN												
Montana	1	0	1	12	41	41	23	235	16	0	0	0
Idaho	3	0	1	5	2	4	52	94	24	0	0	0
Wyoming [4]	2	0	0				29	92	46	0	0	0
Colorado [4] [5]	12	14	9	23	35		25	536	315	0	2	1
New Mexico	4	0	3		23	15	29	28	35	1	1	1
Arizona	1	5	2	93	151	53	53	38	40	0	0	0
Utah [2]	0	0	0	7	42		636	110	23	0	1	0
PACIFIC												
Washington	0	0	0		10	1	763	797	228	0	0	1
Oregon [4]	5	2	2	11	44	44	642	70	70	0	0	0
California	14	16	20	186	145	145	455	3,482	1,645	1	3	3
Total	272	335	398	2,842	6,141	3,201	9,746	15,056	15,056	36	47	158
15 weeks	5,485	7,242	8,547	155,283	129,527	115,788	95,996	196,334	196,334	595	766	1,984

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended April 13, 1940, and comparison with corresponding week of 1939 and 5-year median—Con.

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid and paratyphoid fever		
	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39
	Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939		Apr. 13, 1940	Apr. 15, 1939	
NEW ENG.												
Maine	0	0	0	13	20	18	0	0	0	0	2	2
New Hampshire	0	0	0	7	3	10	0	0	0	0	0	0
Vermont	0	0	0	3	14	9	0	0	0	0	0	0
Massachusetts	0	0	0	187	200	308	0	0	0	0	1	1
Rhode Island	0	0	0	12	14	18	0	0	0	0	0	0
Connecticut	0	0	0	97	102	105	0	0	0	3	0	0
MID. ATL.												
New York	1	0	0	998	601	1,034	0	0	0	5	9	6
New Jersey	0	0	0	435	214	214	0	0	0	3	4	1
Pennsylvania	0	0	0	482	295	625	0	0	0	6	3	7
E. NO. CEN.												
Ohio	1	0	0	310	408	408	1	19	2	4	1	4
Indiana	0	0	0	162	172	172	0	33	14	5	1	1
Illinois	0	1	1	773	514	789	0	10	10	1	3	4
Michigan [2]	1	0	0	373	474	474	0	3	3	0	2	4
Wisconsin	0	0	0	122	175	289	2	0	7	2	0	2
W. NO. CEN.												
Minnesota	0	0	0	29	52	163	3	4	6	1	1	0
Iowa	0	0	0	78	186	204	19	47	47	1	0	0
Missouri	0	1	0	41	68	167	3	36	23	1	2	2
North Dakota	0	0	0	7	13	17	0	5	5	1	1	0
South Dakota	0	0	0	17	23	23	2	11	11	0	1	0
Nebraska	0	0	0	15	27	36	0	31	24	0	0	0
Kansas	0	1	0	52	81	153	0	3	37	2	1	1
SO. ATL.												
Delaware	0	0	0	5	7	11	0	0	0	0	0	0
Maryland [2]	0	0	0	35	47	58	0	0	0	1	1	1
District of Columbia	0	0	0	25	18	21	0	0	0	0	1	1
Virginia	0	0	0	39	29	41	0	0	0	3	3	3
West Virginia [3]	2	1	0	66	29	39	0	2	0	1	0	3
North Carolina	0	0	0	28	18	22	0	0	0	0	3	2
South Carolina	0	8	0	0	6	6	0	0	0	2	3	3
Georgia [3]	0	0	0	12	14	8	0	0	0	4	1	3
Florida [3]	0	0	0	4	9	6	0	0	0	0	5	3
E. SO. CEN.												
Kentucky	0	0	0	79	80	47	0	9	2	5	5	5
Tennessee [3]	1	1	1	80	66	28	6	1	0	4	0	5
Alabama [3]	0	0	0	15	12	7	1	0	0	3	8	2
Mississippi [2]	1	0	1	7	2	6	2	0	0	1	0	5
W. SO. CEN.												
Arkansas	0	0	0	4	3	3	3	1	0	4	1	0
Louisiana	0	0	0	7	12	12	0	1	0	3	10	10
Oklahoma	0	0	0	33	24	24	0	34	7	2	1	1
Texas [3]	0	2	1	25	40	118	5	17	11	2	16	13
MOUNTAIN												
Montana	0	0	0	30	9	18	0	1	9	2	0	0
Idaho	0	0	0	16	6	11	1	3	3	1	0	0
Wyoming [4]	0	0	0	4	3	7	0	0	2	2	0	0
Colorado [4 5]	0	0	0	44	34	43	18	1	4	3	0	0
New Mexico	0	0	0	16	5	14	0	0	0	1	1	0
Arizona	0	1	0	6	2	16	0	0	0	1	1	0
Utah [2]	1	0	0	15	21	40	0	0	0	0	0	0
PACIFIC												
Washington	1	0	0	44	39	39	0	4	15	1	1	1
Oregon [4]	0	0	0	14	26	53	1	4	4	0	3	2
California	2	3	4	129	192	213	5	26	18	4	3	4
Total	11	19	19	4,995	4,409	7,138	72	306	306	85	99	99
15 weeks	386	230	307	71,706	77,735	103,233	1,073	5,421	4,698	1,165	1,741	1,741

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended April 13, 1940, and comparison with corresponding week of 1939 and 5-year median—Continued.

Division and State	Whooping cough, week ended—	
	Apr. 13, 1940	Apr. 15, 1939
NEW ENG.		
Maine	38	78
New Hampshire	20	4
Vermont	28	36
Massachusetts	175	192
Rhode Island	5	65
Connecticut	24	111
MID. ATL.		
New York	440	430
New Jersey	99	329
Pennsylvania	357	308
E. NO. CEN.		
Ohio	174	157
Indiana	41	57
Illinois	114	260
Michigan [2]	137	149
Wisconsin	91	192
W. NO. CEN.		
Minnesota	30	49
Iowa	9	17
Missouri	7	25
North Dakota	12	3
South Dakota	2	1
Nebraska	8	2
Kansas	50	21
SOUTH ATLANTIC		
Delaware	2	16
Maryland [2]	180	23
District of Columbia	10	27
Virginia	38	56
West Virginia [2]	49	57
North Carolina	106	222
SOUTH ATLANTIC—continued		
South Carolina	21	82
Georgia [3]	14	32
Florida [3]	19	31
EAST SOUTH CENTRAL		
Kentucky	115	10
Tennessee [3]	55	30
Alabama [3]	31	15
Mississippi [2]	----	----
WEST SOUTH CENTRAL		
Arkansas	24	24
Louisiana	43	11
Oklahoma	20	1
Texas [3]	386	90
MOUNTAIN		
Montana	3	5
Idaho	15	4
Wyoming [4]	3	5
Colorado [4] [5]	22	68
New Mexico	45	9
Arizona	37	24
Utah [2]	119	29
PACIFIC		
Washington	55	22
Oregon [4]	39	12
California	305	193
Total	3,617	3,584
15 weeks	44,968	61,897

[1] New York City only.
[2] Period ended earlier than Saturday.
[3] Typhus fever, week ended Apr. 13, 1940, 11 cases as follows: Georgia, 4; Florida, 3; Tennessee, 1; Alabama, 2; Texas, 2.
[4] Rocky Mountain spotted fever, week ended Apr. 13, 1940, 3 cases as follows: Wyoming, 2; Colorado, 1; Oregon, 1.
[5] Colorado tick fever, week ended Apr. 13, 1940, Colorado, 2 cases.

WEEKLY REPORTS FROM CITIES

City reports for week ended Mar. 30, 1940

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.

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								
Data for 90 cities:											
5-year average	147	438	100	8,015	837	2,440	26	392	20	1,231	-----
Current week	54	237	61	2,001	506	2,023	1	344	15	863	-----
Maine:											
Portland	0	-----	0	83	1	2	0	0	0	3	33
New Hampshire:											
Concord	0	-----	0	0	0	0	0	0	0	0	10
Manchester	0	-----	1	10	2	2	0	1	0	0	28
Vermont:											
Barre	0	-----	0	0	0	0	0	2	0	0	6
Burlington	0	-----	0	0	0	0	0	0	0	0	8
Rutland	0	-----	0	0	1	0	0	0	0	0	7
Massachusetts:											
Boston	0	-----	0	65	16	55	0	13	2	27	243
Fall River	1	-----	0	36	2	1	0	2	0	11	26
Springfield	0	-----	0	0	2	4	0	0	0	1	35
Worcester	0	-----	0	3	10	3	0	1	0	7	49
Rhode Island:											
Pawtucket	0	-----	0	0	0	1	0	0	0	0	14
Providence	0	-----	1	118	6	12	0	2	0	8	66
Connecticut:											
Bridgeport	0	1	1	0	1	4	0	1	1	0	42
Hartford	0	-----	0	0	2	4	0	0	0	4	39
New Haven	0	2	1	0	3	2	0	1	0	0	47
New York:											
Buffalo	0	-----	1	0	11	12	0	0	0	4	152
New York	19	15	6	77	84	656	0	87	4	120	1,500
Rochester	0	1	0	3	4	6	0	1	0	8	74
Syracuse	0	-----	0	0	5	5	0	0	0	4	50
New Jersey:											
Camden	0	2	2	0	0	13	0	0	0	4	30
Newark	0	5	0	257	7	39	0	6	0	5	114
Trenton	0	-----	0	0	7	5	0	1	0	0	53
Pennsylvania:											
Philadelphia	2	7	2	37	25	97	0	22	1	35	558
Pittsburgh	1	3	1	0	16	23	0	9	0	8	231
Reading	0	-----	1	1	1	0	0	0	0	9	40
Scranton	0	-----	-----	0	-----	0	0	-----	0	0	-----
Ohio:											
Cincinnati	1	1	2	5	10	14	0	5	0	18	121
Cleveland	1	29	0	3	9	23	0	9	0	31	206
Columbus	0	2	2	0	6	7	0	4	1	7	93
Toledo	0	-----	0	1	8	41	0	6	0	17	82
Indiana:											
Anderson	0	-----	0	0	1	2	0	0	0	4	9
Fort Wayne	1	-----	1	0	5	1	0	1	0	5	34
Indianapolis	1	-----	2	3	5	22	0	6	0	8	110
Muncie	0	-----	1	0	2	2	0	1	0	2	19
South Bend	0	-----	0	0	0	0	0	0	0	0	20
Terre Haute	0	-----	0	0	1	2	0	0	0	2	26
Illinois:											
Alton	1	-----	0	0	0	0	0	0	0	4	11
Chicago	5	8	3	34	30	601	0	40	1	60	746
Elgin	1	-----	0	1	0	3	0	0	0	0	11
Moline	0	-----	0	0	0	4	0	0	0	0	6
Springfield	0	-----	0	0	1	3	0	0	0	5	14
Michigan:											
Detroit	2	1	4	35	13	63	0	12	0	12	273
Flint	0	-----	0	0	2	25	0	0	0	15	26
Grand Rapids	0	-----	0	11	3	24	0	0	0	9	31
Wisconsin:											
Kenosha	0	-----	0	11	0	0	0	0	0	0	9
Madison	0	-----	0	1	0	1	0	0	0	5	19
Milwaukee	0	1	1	7	6	25	0	0	0	0	104
Racine	0	-----	0	1	0	1	0	0	0	1	13
Superior	0	-----	0	78	1	0	0	0	0	0	5
Minnesota:											
Duluth	0	-----	0	137	2	1	0	1	1	1	24
Minneapolis	0	-----	0	3	9	25	0	1	0	2	116
St. Paul	0	-----	0	0	5	13	0	2	0	22	72

City reports for week ended Mar. 30, 1940—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								
Iowa:											
Cedar Rapids	0			33		8	0		0	0	
Davenport	2			12		1	0		0	0	
Des Moines	0		0	13	0	10	7	0	0	0	39
Sioux City	1			0		0	0		0	0	
Waterloo	0			0		1	0		0	0	
Missouri:											
Kansas City	0		0	8	8	24	0	6	0	4	130
St. Joseph	0		0	0	3	1	0	0	0	1	27
St. Louis	3		0	2	11	15	0	12	0	7	232
North Dakota:											
Fargo	0		0	1	1	0	1	0	0	0	14
Grand Forks	0			0		0	0		0	1	
Minot	0			0		0	0		0	0	3
South Dakota:											
Aberdeen	0			0		2	0		0	0	
Sioux Falls	0		0	0	0	1	0	0	0	0	8
Nebraska:											
Lincoln	0			1		2	0		0	0	
Omaha	0		0	13	9	7	0	1	0	4	52
Kansas:											
Lawrence	0		0	0	0	0	0	0	0	0	4
Topeka	0		0	2	2	1	0	0	0	0	10
Wichita	0		0	102	5	0	0	0	0	1	25
Delaware:											
Wilmington	0		0	0	6	5	0	2	0	10	35
Maryland:											
Baltimore	1	23	1	2	24	16	0	13	1	156	240
Cumberland	0	1	1	0	0	1	0	0	0	0	16
Frederick	0		0	0	1	0	0	0	0	0	5
District of Col.:											
Washington	3	3	2	0	10	16	0	15	0	7	155
Virginia:											
Lynchburg	0		0	1	1	4	0	0	0	2	14
Norfolk	0	7	0	6	5	2	0	1	0	1	24
Richmond	0		1	2	4	2	0	0	0	0	47
Roanoke	0		0	1	1	1	0	0	0	0	23
West Virginia:											
Charleston	0	4	0	0	1	0	0	1	0	0	18
Huntington	0			0		2	0		0	0	
Wheeling	1		0	0	3	1	0	2	1	2	28
North Carolina:											
Gastonia	0			0		0	0		0	0	
Raleigh	0		0	0	2	0	0	0	0	0	12
Wilmington	0		1	0	0	0	0	0	0	0	12
Winston-Salem	0		0	0	5	3	0	4	0	0	24
South Carolina:											
Charleston	0	28	0	0	0	1	0	0	0	1	14
Florence	0		0	0	3	0	0	0	0	0	15
Greenville	0		0	0	1	0	0	0	0	1	4
Georgia:											
Atlanta	0	12	1	10	8	4	0	5	0	1	78
Brunswick	0		0	0	0	0	0	0	0	0	5
Savannah	0	15	0	0	0	2	0	3	0	0	27
Florida:											
Miami	0	6	1	0	2	1	0	2	0	0	55
Tampa	2	1	1	80	1	1	0	0	0	3	34
Kentucky:											
Ashland	0		0	0	0	2	0	0	0	3	6
Covington	0		0	4	2	1	0	3	0	0	12
Lexington	0		0	0	0	5	0	0	0	1	19
Tennessee:											
Knoxville	0		0	0	1	11	0	0	0	0	28
Memphis	0	12	2	11	5	21	0	4	0	21	90
Nashville	0	5	0	3	1	1	0	0	0	0	56
Alabama:											
Birmingham	0	5	2	3	3	0	0	4	0	1	70
Mobile	0	3	0	0	0	0	0	0	0	0	22
Montgomery	1	3		11		0	0		0	0	
Arkansas:											
Fort Smith	0			0		0	0		0	0	
Little Rock	0	4	0	1	4	3	0	0	0	0	
Louisiana:											
Lake Charles	0		0	1	1	0	0	0	1	0	6
New Orleans	2	5	0	11	11	17	0	13	0	24	139
Shreveport	0		1	1	12	0	0	4	0	0	67

City reports for week ended Mar. 30, 1940—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								
Oklahoma:											
Oklahoma City	0	------	0	0	3	3	0	1	0	0	57
Tulsa	0	------	-------	0	------	3	1	------	0	20	-------
Texas:											
Dallas	2	5	5	55	4	2	0	2	0	24	80
Galveston	0	------	0	1	2	1	0	1	0	0	14
Houston	0	1	2	10	7	3	0	8	1	5	79
San Antonio	1	4	2	47	6	0	0	9	0	1	73
Montana:											
Billings	0	------	0	0	1	0	0	0	0	0	7
Great Falls	0	------	0	1	0	2	0	0	0	0	7
Helena	0	------	0	0	0	0	0	0	1	0	3
Missoula	0	------	0	0	1	1	0	0	0	0	8
Idaho:											
Boise	0	------	0	1	0	0	0	0	0	0	9
Colorado:											
Colorado Springs	0	------	0	2	3	1	0	1	0	2	16
Denver	2	------	0	18	7	9	0	2	0	1	96
Pueblo	0	------	0	3	1	10	0	1	0	0	13
New Mexico:											
Albuquerque	0	------	0	1	0	1	0	2	0	8	13
Utah:											
Salt Lake City	0	------	0	166	2	1	0	0	0	51	32
Washington:											
Seattle	0	------	3	392	7	2	0	1	0	31	91
Spokane	0	1	1	4	3	4	0	1	0	8	37
Tacoma	0	------	0	9	0	0	0	0	0	0	34
Oregon:											
Portland	2	1	0	261	10	4	0	1	0	11	92
Salem	0	------	-------	6	------	0	0	------	0	0	-------
California:											
Los Angeles	1	26	4	20	9	29	0	19	0	16	363
Sacramento	1	------	0	11	1	7	0	1	0	14	30
San Francisco	1	1	0	1	2	11	0	11	0	11	182

State and city	Meningococcus meningitis		Poliomyelitis cases	State and city	Meningococcus meningitis		Poliomyelitis cases
	Cases	Deaths			Cases	Deaths	
New York:				Georgia:			
Buffalo	1	0	0	Savannah	1	0	0
New York	0	0	1	Louisiana:			
Ohio:				Shreveport	0	1	0
Cleveland	0	1	0	Texas:			
Illinois:				Houston	3	0	0
Chicago	2	1	0	Washington:			
District of Columbia:				Spokane	0	1	0
Washington	1	0	0	California:			
West Virginia:				San Francisco	1	0	0
Huntington	1	1	0				

Dengue.—Cases: Charleston, S. C., 1.
Encephalitis, epidemic or lethargic.—Cases: New York, 2; Houston, 1; Great Falls, 1.
Pellagra.—Cases: Charleston, S. C., 1; Miami, 1.
Typhus fever.—Cases: New York, 1; New Orleans, 1; Houston, 1.

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Weeks ended March 16 and 23, 1940.—During the weeks ended March 16 and 23, 1940, cases of certain communicable diseases were reported by the Department of Pensions and National Health of Canada as follows:

Week ended March 16, 1940

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Cerebrospinal meningitis		1	2	1	2					6
Chickenpox		4	6	226	484	29	17	10	71	847
Diphtheria		1		25		2	3			31
Dysentery				4	3					7
Influenza		37	6		80	5			24	152
Measles		1		230	1,313	601	68	5	28	2,246
Mumps				75	438	9	17	2	8	549
Pneumonia					66	3	1		10	80
Scarlet fever		5	8	96	290	5	19	34	25	482
Trachoma					1				1	2
Tuberculosis	2	13	10	67	100	32		5		229
Typhoid and paratyphoid fever				26	2	2		2		32
Whooping cough		4		130	115	63	49	22	28	411

Week ended March 23, 1940

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Cerebrospinal meningitis				2	2		1			5
Chickenpox		12		210	309	36	32	1	30	630
Diphtheria			1	21	2		1			25
Dysentery				24						24
Influenza		32			40				91	163
Measles		12		213	373	561	131	3	59	1,352
Mumps				70	405	14	16	1	3	509
Pneumonia		6			24	2	2		11	45
Scarlet fever		6	7	90	159	8	11	12	12	305
Trachoma									7	7
Tuberculosis		3	10	56	22	3	28	1		123
Typhoid and paratyphoid fever			1	20	2	16		1	1	41
Whooping cough		12		138	97	40	31	2	17	337

NOTE.—No cases of the above diseases were reported from Prince Edward Island for the week ended Mar. 23, 1940.

REPORTS OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER RECEIVED DURING THE CURRENT WEEK

NOTE.—A cumulative table giving current information regarding the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS of March 29, 1940, pages 567–571. A similar table will appear in future issues of the PUBLIC HEALTH REPORTS for the last Friday of each month.

Cholera

Indochina (French).—During the period February 11–29, 1940, cholera was reported in French Indochina as follows; Louang Prabang, 7 cases, 3 deaths; Vientiane, 307 cases, 201 deaths.

Plague

Hawaii Territory—Island of Hawaii—Hamakua District—Hamakua Mill Area.—A rat found on March 12 and another rat found on March 15, 1940, in Hamakua Mill Area, Hamakua District, Island of Hawaii, T. H., have been proved positive for plague.

Indochina (French)—Kandal.—During the period February 19–29, 1940, one case of plague was reported in Kandal, French Indochina.

Peru.—During the month of January 1940, plague was reported in Peru, by Departments, as follows: Lambayeque, 5 cases, 4 deaths; Libertad, 25 cases, 11 deaths; Lima, 11 cases, 9 deaths; Piura, 3 cases, 1 death.

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