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Evaluation of County-Wide DDT Dusting Operations in Murine Typhus Control [1]

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The recognition of murine typhus fever as an epidemiological syndrome is relatively recent. In 1926 Maxcy (*1*) suggested the role of the domestic rat in the transmission of typhus fever in the United States. Five years later the role of the rat was proved by the work of Dyer, Rumreich and Badger (*2*). Thereafter, until 1944, the trend of reported cases was steadily upward. From 1940 through 1944, this trend of incidence (*3*) showed an alarming increase with 5,353 cases reported during 1944 (figure 1). Attempts at controlling murine typhus fever on a city or county-wide basis (*4*, *5*, *6*) had met with varying degrees of success. Work in progress during 1945 (*5*) indicated that DDT might be an effective material for controlling rat fleas. Due to the apparent urgency of the situation, steps were taken to incorporate DDT dusting techniques into existing typhus control programs, and coincidentally an acceleration and expansion of this type of work was undertaken in the Southern States most heavily affected by murine typhus fever (figure 2).

The nation-wide decline in murine typhus fever incidence from 1945 to 1947 (figure 1) might have been due to a multiplicity of factors other than the introduction of DDT dusting. In 1945 the question as to whether or not DDT application could be made practical for the control of murine typhus fever on a community-wide basis, remained unanswered. Since new methods require objective evaluation in order to employ them in their proper place in the total public health program of the community, it was deemed advisable to carry on a comprehensive study to determine whether or not DDT dusting on a county-wide basis would measurably reduce the incidence of murine

[1] From Communicable Disease Center, Atlanta, Ga. This study was made cooperatively with the Georgia Department of Public Health, Typhus Control Service, Roy J. Boston, Director.

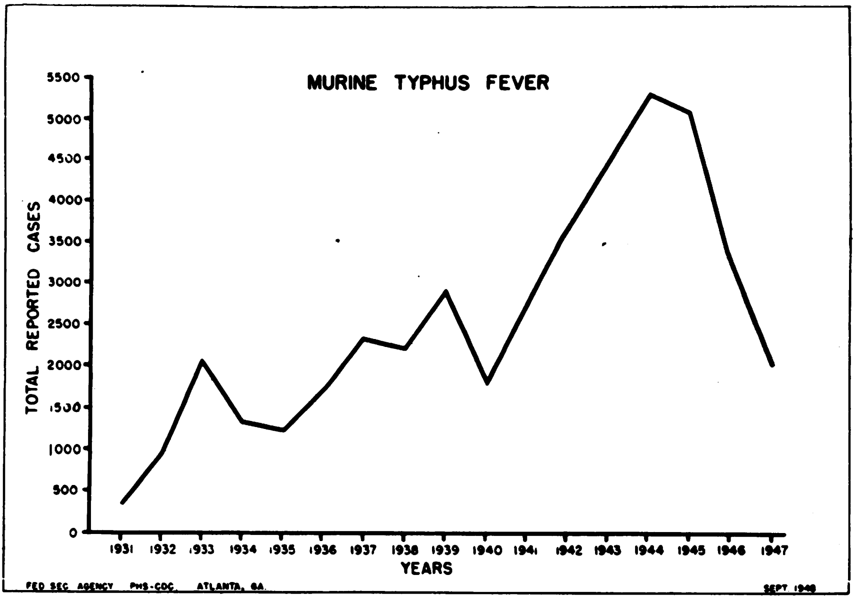

Figure 1. Reported cases of murine typhus fever in the United States, 1931–1947

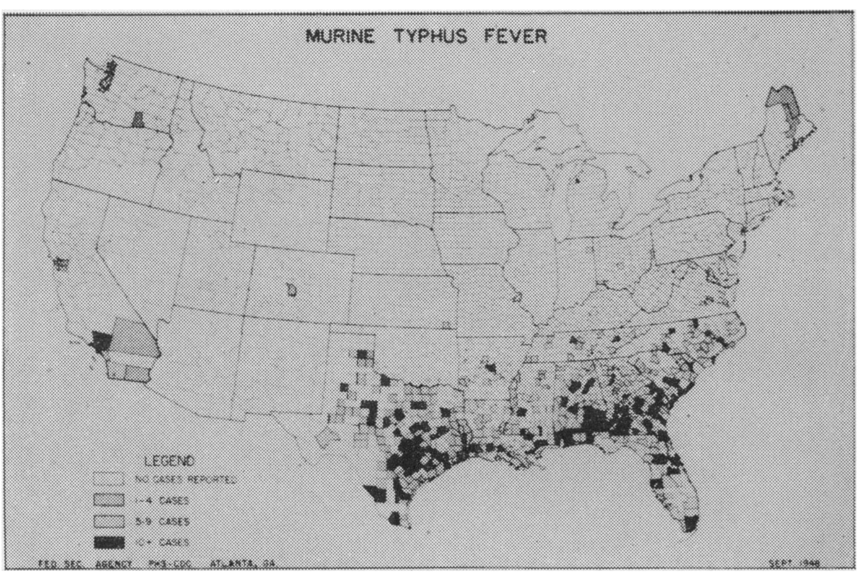

Figure 2. Reported cases of murine typhus fever in the United States, 1944

typhus fever in humans. The study was also to determine whether or not one or more of the abundant species of rat ectoparasites would be effectively controlled throughout the treated areas, to measure any reduction of typhus in the rat reservoir, and to observe any association between ectoparasite control and reduction of typhus in rat and man.

A survey in the latter part of 1945 revealed that an area in southwest Georgia, which includes Brooks, Thomas, and Grady Counties, was of appropriate size and otherwise suitable for such a study project. Through the cooperation of the Georgia Department of Public Health, this area was made available for the study, and Dr. C. D. Bowdoin and Roy J. Boston *(6, 7)* of that agency assisted in expediting the establishment of the investigations. Headquarters for the project were located at Thomasville.

Methods

Since conditions surrounding human populations were not expected to remain static, the span of time over which the study could be conducted was considered limited to a period of about 2 to 5 years. Therefore, principal reliance was placed upon concurrent comparisons but, insofar as it was possible, data which antedated the DDT typhus control operations were obtained for comparison with subsequent data. In this study, objective measurements of three principal points of reference were undertaken. Each of these was subject to determination or confirmation by specific objective techniques. These points of reference consisted of the measurement of recognized, confirmed murine typhus fever incidence among humans, the prevalence of murine typhus complement fixing antibodies in the rat population determined on a representative sampling basis, and the abundance of the principal rat ectoparasites with sampling methods paralleling those for rat serological studies.

Grady County, with an area of 444 square miles, was studied as an untreated check. Thomas County, with an area of 530 square miles, and Brooks County, 514 square miles in area, were treated and details of the DDT dusting operations are shown in table 1. Population data for the three counties are given in table 3.

While steps were taken to avoid community-wide undertakings which might introduce bias factors into the measurements obtained, the controlled perfection of a laboratory experiment was not expected. Before the epidemiological trends of human incidence, reservoir prevalence and potential vector abundance were considered significant, they were subjected to exacting statistical tests. Observations indicated that very little activity relevant to typhus control took place in Thomas or Brooks Counties other than that resulting from individual initiative, private enterprise, or the DDT dusting work which was under the auspices of the study project. In Grady County individual initiative and private enterprise were probably closely parallel to the two treated counties. However, a locally sponsored household clean-up drive was carried on in Cairo, the county seat of Grady County, during 1947.

Table 1. *Summary of DDT dusting operations for murine typhus control in Brooks and Thomas Counties from April 1, 1946, through September 30, 1947*

Dusting periods	Establishments treated	Percent treated establishments [1]	Pounds of 10 percent DDT dust used	Average pounds of 10 percent DDT dust per establishment treated
Brooks County				
1. Apr. 1 through June 28, 1946	4,322	83	19,717	4.6
2. July 1 through Oct. 2, 1946	4,731	91	17,081	3.6
3. Oct. 3 through Dec. 31, 1946	4,016	77	25,145	6.3
4. Mar. 31 through May 30, 1947	4,511	87	22,967	5.1
5. Aug. 1 through Sept. 30, 1947	5,014	96	20,782	4.1
Thomas County				
1. May 13 through July 3, 1946	8,157	92	18,702	2.3
2. July 15 through Oct. 4, 1946	6,939	78	16,288	2.3
3. Oct. 7 through Dec. 23, 1946	5,333	60	36,321	6.8
4. Feb. 2 through Mar. 29, 1947	6,532	74	33,243	5.1
5. June 2 through July 30, 1947	8,156	92	19,090	2.3

[1] Computed on the basis of a total of 5,207 establishments in Brooks County and 8,881 establishments in Thomas County; as indicated by project census figures. Premises not treated include both absentees and refusals.

Dusting Operations—In the conduct of DDT dusting operations in Thomas and Brooks Counties, an effort was made to distribute 10 percent DDT in pyrophyllite in such a manner that rats would be forced to cross through patches of it to travel from harborage to food and water supplies. Since rat populations of treated areas were predominantly *Rattus rattus*, it was necessary to train personnel to accomplish thorough coverage of overhead runs as well as those at the ground level. When at all possible, dust was applied to rat harborages, but often because of structural characteristics of buildings or storage of stock feed, these harborage places were inaccessible. Reliance was necessarily placed upon thorough treatment of accessible rat runs. Repeated observations indicated that rats would traverse thin dust patches, whereas they frequently avoided those which were much more than one-eighth of an inch deep. Therefore, it was considered possible to obtain better rat ectoparasite control by using less material in the individual patches.

Men engaged in the dusting operations gradually evolved a method of hand dusting that was highly efficient. They were able to place packed handfuls of the material on any desired location, even to a height of about 20 feet. Unintentional dusting of stored feed and personnel engaged in the work was avoided more effectively by hand application than formerly had been the case with a plunger-type dust gun and other less satisfactory equipment. More thorough coverage of all rat runs was accomplished, estimation of quantity of DDT dust used per treated establishment was more accurate, and a considerable saving in time resulted from hand dusting.[2]

Table 2. ***Rats from Thomas and Brooks Counties examined for murine typhus complement fixing antibodies and the percent from establishments treated with 10 percent DDT dust*** [1]

Period	Thomas County		Brooks County		Period	Thomas County		Brooks County	
	Number rats examined	Percent rats from dusted establishments	Number rats examined	Percent rats from dusted establishments		Number rats examined	Percent rats from dusted establishments	Number rats examined	Percent rats from dusted establishments
1946					*1947*				
May	188	0	176	86.9	May	140	93.6	180	94.4
June	220	80.0	130	86.9	June	149	98.0	181	96.7
July	112	77.7	98	84.7	July	154	99.4	219	100.0
August	109	88.1	100	90.0	August	153	100.0	225	99.1
September	115	88.7	93	90.3	September	170	100.0	176	100.0
October	176	82.4	143	93.7	October	221	100.0	264	100.0
November	81	86.4	83	90.4	November	161	99.4	150	100.0
December	63	87.3	101	97.0	December	168	100.0	163	100.0
1947					*1948*				
January	97	90.7	102	98.0	January	156	100.0	146	100.0
February	92	94.6	113	99.1	February	162	100.0	160	100.0
March	132	90.2	141	100.0	March	270	100.0	163	100.0
April	152	80.3	203	96.0	April	286	100.0	193	100.0
Total	1,537	74.6	1,483	92.9	Total	2,190	99.4	2,220	99.2

[1] Rat sampling was maintained on a basis which was representative of each county as a whole regardless of the status of murine typhus control operations.

Five rounds of dusting were accomplished in each of the treated counties between April 1, 1946, and September 30, 1947, with 60 to 96 percent of premises receiving treatment in separate county-wide cycles of dusting activity (table 1). In Brooks County the first round of DDT dusting operations started April 1, 1946, while in Thomas County the first round started May 13, 1946. From May 1946 through April 1947, 92.9 percent of the Brooks County rats which were tested for murine typhus complement fixing antibodies, and 74.6 percent of those tested from Thomas County, came from premises which had been treated with DDT dust (table 2). During the following year, over 99 percent of the rats examined from both counties came from treated premises. Wherever there was a choice of epidemiological methods, that method which might be expected to reflect least credit on DDT dusting operations was selected in order to provide conservative measurements of the county-wide epidemiological phenomena being studied.

[2] Clinical observation of personnel engaged in dusting operations, including photofluorographic examination, revealed no ill effects which could be attributed to exposure to the DDT-pyrophyllite mixture.

Since the human incidence of murine typhus fever was relatively low, a method designed to encompass the total county-wide incidence was imperative. A decrease of about 60 percent would be necessary before a phenomenon, such as human murine typhus morbidity with an annual rate of about 100 per 100,000 in a population of 20,000 could be considered statistically significant.

Rat Populations Sampled—Murine typhus antibody prevalence rates in the domestic rat populations of about 45 percent in Grady, 50 percent in Brooks, and 55 percent in Thomas County made it possible to sample the rat populations with 16 geographically representative trapping stations in each county. An effort was made to include in each station a sufficient number of rat-infested premises to supply a live-rat sample of from 10 to 20 each month, without materially affecting the over-all rat population of the station.

Repeated rat-trapping activities took place within the stations each month of the study. Extra-station trapping was carried out in order to provide a relatively complete county-wide survey and as a check on the possible changes which might result from repeated trapping within the stations. This type of trapping also seemed adequate to support the studies of rat ectoparasite abundance.

As rats were collected they were brought to the headquarters of the project to be bled and their ectoparasites collected, counted, and identified. For the purpose of this study, a titer of one to four or higher with the murine typhus complement fixation test was considered sufficient to place the rat among those possessing demonstrable antibodies for *Rickettsia typhi* (Wolbach and Todd) Philip.[3] While most of the rat sera were subjected only to the murine typhus complement fixation test, sufficient numbers of specimens were tested with other rickettsial antigens to demonstrate the improbability of obtaining significant numbers of confusing cross reactions.

Data recorded on each rat included information identifying the location and type of habitat from which the rat was taken, body length, tail length, sex, species, and whether adult or young. The basis for age classification was sexual maturity; that is, if the testes were confined to the abdomen or the vagina imperforate they were considered young, otherwise they were classified as adults. In addition to this basic identifying data, the number and species of ectoparasites infesting each rat and the serological results were added to the record.

Human-Case Investigations—Since a retrospective study of human cases occurring in 1945 was included in the project, six screening methods were employed. These included reports from State and local health departments, hospital records, laboratory records, contact with

[3] The etiological agent of murine typhus fever has appeared in the literature under several names, *R. mooseri, R. prowazeki* var. *mooseri, R. muricola, R. murina.*

physicians, reputed cases picked up on information in the nature of rumor, and door-to-door survey. While the door-to-door survey was indispensable for the retrospective study of 1945 cases, by the middle of 1946, the other five methods were found to be adequate for keeping abreast of current cases. This elimination of an expensive procedure was made possible by personnel of the project becoming familiar with the areas in which they worked and with the families in those areas, so that the desirable features of the door-to-door survey were actually retained.

In connection with each human-case investigation, basic identifying data, possible sources of infection, clinical characteristics and laboratory results were recorded. Clinical histories were evaluated in order to classify them as clear-cut history of murine typhus fever, possible murine typhus fever history, inadequate clinical information or negative histories. Each human case was charged to the county of residence, regardless of a history which might indicate exposure elsewhere.

The final objective criterion for considering a case confirmed depended upon the serological results obtained. The complement fixation test for murine typhus was selected for confirming or rejecting a human case. Since human blood specimens were frequently obtained at considerable lengths of time after the illness, a titer of one to four or higher was ordinarily considered sufficient to place a case in the confirmed group. In most confirmed cases where the initial test produced a titer of one to four, a subsequent serum specimen was obtained that gave a positive test at a titer of one to four or higher. This criterion was followed if tests with other rickettsial antigens failed to yield equal or higher titers. However, in cases giving a history of prior rickettsial infection or active immunization, especially strong clinical and laboratory evidence was required before considering the case confirmed. This evidence included the typical clinical syndrome of murine typhus fever and rising serological titers during the course of the illness being studied.

In order to check serological results obtained in the Communicable Disease Center laboratory, some serological specimens were divided and portions sent to one or more of the following laboratories: (1) National Institutes of Health, Bethesda, Maryland,[4] (2) Georgia Department of Public Health, Regional Laboratory, Albany, Georgia,[5] (3) Lederle Laboratory, Pearl River, New York.[6] As with the human sera, occasionally rat serum specimens also were examined by more than one laboratory.

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[4] Dr. Robert Huebner.
[5] Frank Stubbs.
[6] Dr. Herald Cox.

Results

For the 18-month period prior to the completion of the first DDT dusting cycle in both Thomas and Brooks Counties, and including January 1945 through June 1946, the murine typhus incidence rate was 232.1 for Grady County (figure 3); 180.2 for Thomas County; and 174.1 for Brooks County, with the incidence of officially reported cases only 37.2 percent, 46.2 percent, and 34.8 percent of these respective values.[7] These data provided an indication that the three counties were sufficiently similar prior to the DDT dusting operations to permit valid subsequent comparisons.

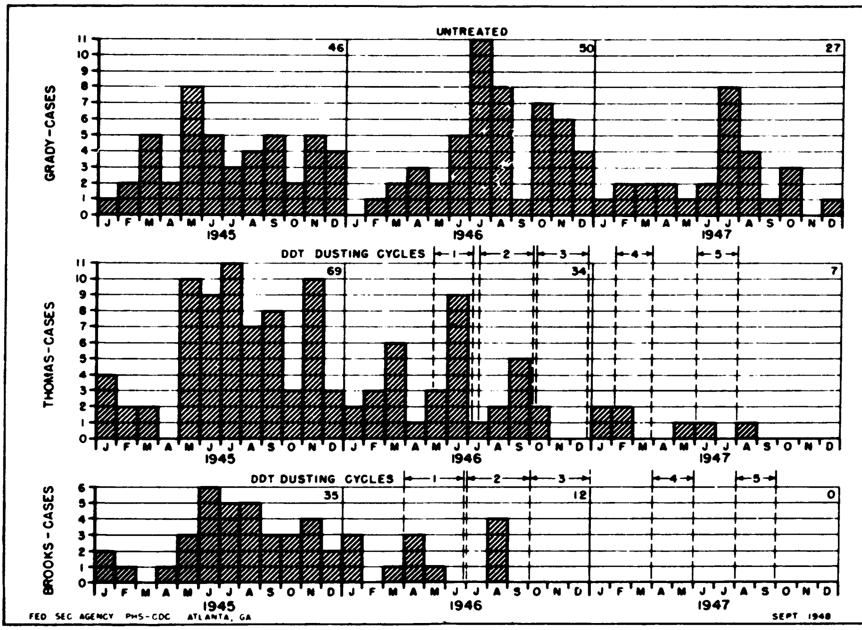


Figure 3. Human cases of murine typhus fever by month of onset, confirmed by the murine typhus complement fixation test 1945 through 1947

Rate Decreases in Treated Counties—The first cycle of DDT dusting operations was completed in both Thomas and Brooks Counties July 3, 1946. During the period of July 1946 through December 1947 (figure 3), the murine typhus incidence rate was 235.9 for Grady County (untreated), 31.5 for Thomas County, and 14.7 for Brooks County. Not a single case was found in Brooks County from September 1946 through April 1948. Thomas and Brooks County experience, in contrast with Grady County, represented significant decreases in human incidence of murine typhus fever subsequent to DDT dusting operations. Likewise when the human incidence experience for 18

[7] Data on reported murine typhus fever cases was obtained from Georgia Department of Public Health.

months prior to July 1, 1946, was compared with that in the subsequent 18 months, highly significant reductions were noted following DDT dusting operations in Thomas and Brooks Counties, while no significant change took place in Grady County. The incidence in the period, July 1946–December 1947, containing two peak seasons, would ordinarily be considerably greater than the incidence in the period January 1945–June 1946, containing only one seasonal peak.

Data in table 3 indicate that recognized, confirmed cases of murine typhus fever occurred with greater frequency among white males than in any other population group. In Grady County, the rural and urban human incidence rates for 1945 were not significantly different. The 1945 rural-urban distribution noted for Thomas County, with a 261.5 rural rate and a 115.8 urban rate, indicated a greater chance for infection among rural residents (*6*). A similar tendency existed in Brooks County with a rural rate of 263.2 and an urban rate of 57.6, for 1945. During 1946, the difference between the rural and urban murine typhus morbidity rates for Grady (untreated) and Thomas (treated) Counties was insignificant, while in Brooks (treated) County a slight difference in rates persisted and continued to indicate a greater chance of rural residents acquiring recognized murine typhus fever. In 1947, the rural morbidity rate was significantly greater than the urban rate in Grady County. The number of typhus cases which occurred in 1947 in the two dusted counties, Thomas and Brooks, were 7 and 0, respectively, while in the undusted county, Grady, 27 cases were recorded (figure 3).

Although the decrease in human incidence rate of murine typhus fever in Grady County from 295.4 per 100,000 in 1946 to 146.0 in 1947 was not statistically significant, the decrease in the urban rate (Cairo) from 253.2 in 1946 to 18.2 in 1947 was significant. This probably was due to the relatively minor efforts of a local organization in promoting a clean-up campaign in the community. This locally sponsored campaign was started early in 1947 and did not include specifically any community-wide rat- or typhus-control activities. As was predicted early in the study, Grady County showed a tendency, in 1947, to become less useful as an untreated comparison area. However, as a standard comparison for most of the factors associated with the murine typhus epidemiological syndrome, it remained relatively unaltered during the period of this study, and showed promise of continuing to serve in this capacity for another year or two.

The reservoir-vector portions of this study covered in addition to a 2-year period, May 1946 through April 1948, some prior data which did not match the standards of comparability contained in the remainder of the work. These prior data were included in the tabulations, since they were found to be of value for certain crude comparisons.

Table 3. *Confirmed cases of murine typhus fever, estimated populations and case rates per 100,000 from Grady, Thomas, and Brooks Counties for 1945, 1946 and 1947, rural and urban, by race and sex*

Grady County

	Estimated populations: Rural	Estimated populations: Urban	Rural cases	Rate	Urban cases[1]	Rate	Total cases	Rate
1945								
White:								
Male	3,991	1,046	20	501.1	7	669.2	27	536.0
Female	4,760	1,248	10	210.1	6	480.8	16	266.3
Total	8,751	2,294	30	342.8	13	566.7	43	389.3
Colored:								
Male	1,848	764	1	54.1	0	------	1	38.2
Female	2,212	916	0	------	2	218.3	2	63.9
Total	4,060	1,680	1	24.6	2	119.1	3	52.2
TOTAL	**12,811**	**3,974**	**31**	**242.0**	**15**	**377.4**	**46**	**274.1**
1946								
White:								
Male	4,182	1,549	19	454.3	7	451.9	26	453.6
Female	4,133	1,530	14	338.7	6	392.2	20	353.2
Total	8,315	3,079	33	396.9	13	422.2	46	403.7
Colored:								
Male	1,882	1,012	4	212.5	0	------	4	138.2
Female	1,935	1,041	0	------	0	------	0	------
Total	3,817	2,053	4	104.8	0	------	4	68.1
TOTAL	**12,132**	**5,132**	**37**	**305.0**	**13**	**253.3**	**50**	**289.6**
1947								
White:								
Male	4,326	1,660	12	277.4	1	60.2	13	217.2
Female	4,274	1,640	14	327.6	0	------	14	236.7
Total	8,600	3,300	26	302.3	1	30.3	27	226.8
Colored:								
Male	2,169	1,085	0	------	0	------	0	------
Female	2,231	1,115	0	------	0	------	0	------
Total	4,400	2,200	0	------	0	------	0	------
TOTAL	**13,000**	**5,500**	**26**	**200.0**	**1**	**18.2**	**27**	**145.2**

Thomas County

	Estimated populations: Rural	Estimated populations: Urban	Rural cases	Rate	Urban cases[1]	Rate	Total cases	Rate
1945								
White:								
Male	5,386	3,209	31	575.6	5	155.8	36	418.8
Female	6,425	3,828	20	311.3	7	182.8	27	263.3
Total	11,811	7,037	51	431.8	12	170.5	63	334.2
Colored:								
Male	3,849	3,082	2	51.1	2	64.8	4	57.7
Female	4,611	3,693	0	------	2	54.2	2	24.2
Total	8,460	6,775	2	23.6	4	59.0	6	39.4
TOTAL	**20,271**	**13,812**	**53**	**261.4**	**16**	**115.8**	**69**	**202.4**
1946								
White:								
Male	5,580	4,117	9	161.3	8	194.3	17	175.3
Female	5,513	4,069	11	199.5	4	98.3	15	156.5
Total	11,093	8,186	20	180.3	12	146.6	32	166.0
Colored:								
Male	4,046	3,589	0	------	1	27.8	1	13.1
Female	4,313	3,826	0	------	1	26.1	1	12.2
Total	8,359	7,415	0	------	2	26.2	2	12.6
TOTAL	**19,452**	**15,601**	**20**	**102.8**	**14**	**89.7**	**34**	**97.0**
1947								
White:								
Male	6,489	4,275	1	15.4	0	------	1	9.2
Female	6,411	4,225	5	77.1	1	23.6	6	56.4
Total	12,900	8,500	6	46.5	1	11.8	7	32.7
Colored:								
Male	3,533	3,727	0	------	0	------	0	------
Female	3,767	3,973	0	------	0	------	0	------
Total	7,300	7,700	0	------	0	------	0	------
TOTAL	**20,200**	**16,200**	**6**	**29.7**	**1**	**6.2**	**7**	**19.2**

Brooks County

	Estimated populations: Rural	Estimated populations: Urban	Rural cases	Rate	Urban cases[1]	Rate	Total cases	Rate
1945								
White:								
Male	2,752	804	21	763.2	1	124.4	22	618.6
Female	3,283	960	9	274.1	1	104.2	10	235.7
Total	6,035	1,764	30	497.1	2	113.4	32	410.3
Colored:								
Male	2,960	778	2	67.6	0	------	2	53.5
Female	3,545	933	1	28.2	0	------	1	22.3
Total	6,505	1,711	3	46.1	0	------	3	36.5
TOTAL	**12,540**	**3,475**	**33**	**263.2**	**2**	**57.5**	**35**	**218.5**
1946								
White:								
Male	2,056	2,027	6	291.8	0	------	6	146.2
Female	2,007	1,980	3	149.4	1	50.5	4	100.3
Total	4,063	4,007	9	221.5	1	24.2	10	123.9
Colored:								
Male	2,849	1,225	2	70.2	0	------	2	49.0
Female	3,025	1,301	0	------	0	------	0	------
Total	5,874	2,526	2	34.2	0	------	2	23.8
TOTAL	**9,937**	**6,533**	**11**	**110.7**	**1**	**15.3**	**12**	**72.8**
1947								
White:								
Male	2,176	2,327	0	------	0	------	0	------
Female	2,124	2,273	0	------	0	------	0	------
Total	4,300	4,600	0	------	0	------	0	------
Colored:								
Male	3,444	1,406	0	------	0	------	0	------
Female	3,656	1,494	0	------	0	------	0	------
Total	7,100	2,900	0	------	0	------	0	------
TOTAL	**11,400**	**7,500**	**0**	------	**0**	------	**0**	------

[1] Urban is represented by the county seat in each county. Population data obtained from Georgia Department of Public Health, Division of Vital Statistics.

During the course of the study a change in the domestic rat population began to take place in each of the three counties, with a relative increase in the number of *Rattus norvegicus*. However, *Rattus rattus* consistently outnumbered *R. norvegicus* in the three counties. Due to this variable and many others which were undoubtedly associated with the two reservoir species observed, the reservoir-vector data were analyzed for *R. rattus* and *R. norvegicus* separately.

Trends in prevalence of typhus antibodies in rats recorded in figure 4 and table 4 indicated that the percentage of both species of rats,

Table 4. ***Murine typhus complement fixation results in*** **Rattus rattus** ***and*** **Rattus norvegicus** ***populations of Grady, Thomas and Brooks Counties, Georgia, by months, in the evaluation of DDT dusting operations***

Month	*Rattus rattus*						*Rattus norvegicus* [1]			
	Grady [2]		Thomas [2]		Brooks [2]		Grady [2]		Thomas [2]	
	Number	Percent positive	Number	Percent positive	Number	Percent positive	Number	Percent positive	Number	Percent positive
Preliminary data: [3]										
1945 Oct.-Dec.	------	------	113	52.2	81	50.6	------	------	2	50.0
1946 Jan.-Mar.	------	------	233	50.2	199	46.2	------	------	0	------
1946 April	241	46.5	108	63.0	154	50.0	2	50.0	0	------
1946										
May	86	39.5	164	63.4	176	48.9	25	40.0	24	54.2
June	89	27.0	186	54.8	130	33.1	27	25.9	34	61.8
July	96	39.6	78	41.0	98	26.5	18	44.4	34	32.4
August	63	47.6	87	47.1	100	30.0	12	66.7	22	31.8
September	73	45.2	100	53.0	93	33.3	21	61.9	15	20.0
October	77	39.0	134	36.6	143	26.6	19	42.1	42	31.0
November	40	47.5	76	30.3	83	16.9	16	75.0	5	20.0
December	45	42.2	34	14.7	101	39.6	20	35.0	29	13.8
1947										
January	114	47.4	84	22.6	102	8.8	65	27.7	13	0
February	47	29.8	59	35.6	113	15.0	30	36.7	33	9.1
March	71	52.1	102	23.5	141	10.6	13	46.2	30	10.0
April	128	43.0	138	39.8	203	8.9	45	22.2	14	21.4
Total May 1946–April 1947	929	41.6	1,242	42.5	1,483	24.7	311	37.9	295	27.8
1947										
May	137	39.4	111	18.0	180	6.1	44	43.2	29	0
June	103	38.8	128	10.2	181	7.2	39	20.5	21	4.8
July	204	36.8	115	13.9	219	5.9	47	53.2	39	12.8
August	135	45.2	123	7.3	225	5.8	46	50.0	30	13.3
September	100	43.0	128	2.3	176	4.0	19	31.6	42	16.7
October	133	36.1	141	4.2	264	2.6	40	42.5	80	8.8
November	76	40.8	123	8.1	145	1.4	44	45.4	38	7.9
December	112	37.5	114	9.6	158	1.3	104	42.3	54	1.8
1948										
January	107	19.6	109	0.9	143	1.4	61	39.3	47	4.2
February	91	49.4	113	3.5	156	0	84	27.4	49	4.1
March	182	21.4	197	4.1	159	1.2	77	31.2	73	1.4
April	48	12.5	227	8.4	170	0.6	40	22.5	59	1.7
Total May 1947–April 1948	1,428	35.4	1,629	7.4	2,176	3.4	645	37.5	561	6.1

[1] No *R. norvegicus* were collected from Brooks County until November 1947–April 1948, when 44 were examined serologically with 2.3% positive to the murine typhus complement-fixation test.

[2] Grady County untreated; Thomas County treated with 5 cycles of DDT dusting between May 13, 1946 and July 30, 1947. Brooks County treated with 5 cycles of DDT dusting between April 1, 1946 and September 30, 1947.

[3] Sampling methods used in collecting the preliminary data were not strictly comparable between counties or with subsequent methods.

Table 5. Xenopsylla cheopis *infestation of* Rattus rattus *and* Rattus norvegicus[1] *in Georgia in the evaluation of DDT dusting operations*

Month	Grady County[2]			Thomas County[2]			Brooks County[2]			Grady County[2]			Thomas County[2]		
	Number *R. rattus*	Percent infested	Mean number per rat	Number *R. rattus*	Percent infested	Mean number per rat	Number *R. rattus*	Percent infested	Mean number per rat	Number *R. norvegicus*	Percent infested	Mean number per rat	Number *R. norvegicus*	Percent infested	Mean number per rat
Preliminary data:[3]															
October–December 1945	--------	--------	--------	189	56.6	2.2	177	63.8	2.4	--------	--------	--------	4	75.0	5.7
January–March 1946	--------	--------	--------	278	24.5	.4	280	18.6	.6	--------	--------	--------	0	--------	--------
April 1946	258	45.3	1.3	113	39.8	1.0	200	20.5	.4	2	50.0	3.0	0	--------	--------
1946															
May	116	58.6	3.9	195	51.8	3.8	230	13.5	.4	29	62.1	7.6	31	83.9	5.4
June	148	68.2	8.1	208	50.0	4.2	176	33.0	4.6	42	83.3	12.3	43	27.9	2.0
July	121	81.0	7.0	88	47.7	3.9	188	23.9	1.6	21	100.0	21.8	34	23.5	4.1
August	92	88.0	6.8	104	41.3	1.9	164	18.3	2.0	17	88.2	29.5	25	36.0	.9
September	97	78.4	6.6	122	31.1	1.3	138	22.5	1.5	23	91.3	15.5	17	23.5	3.2
October	118	61.0	2.5	174	20.1	1.3	196	14.3	.5	20	90.0	6.8	45	24.4	1.4
November	49	59.2	4.4	94	12.8	.3	112	5.4	.2	20	70.0	8.4	6	0	0
December	54	51.8	1.8	39	12.8	.4	114	14.9	.3	20	80.0	4.7	30	6.7	.1
1947															
January	126	50.8	1.9	98	17.3	.4	109	2.8	.3	70	47.1	2.0	15	13.3	4.0
February	49	28.6	1.3	65	13.8	.3	118	0	0	30	43.3	.9	34	0	0
March	77	15.6	.4	108	4.6	.1	158	0	0	13	38.5	.7	33	3.0	.1
April	131	45.0	3.1	146	11.0	.2	216	2.3	0	47	36.2	1.5	14	0	0
Total May 19, 1946–April 19, 1947	1,178	59.6	4.3	1,441	29.6	1.9	1,919	13.2	1.0	352	64.2	7.6	327	22.9	1.8
1947															
May	143	37.1	2.0	118	8.5	.2	195	2.0	.2	46	63.0	4.7	30	0	0
June	117	65.8	8.5	136	10.3	.3	210	5.7	.3	44	52.3	9.1	24	12.5	.2
July	215	59.5	4.8	121	3.3	.1	223	4.9	.4	49	65.3	6.0	41	2.4	0
August	147	49.6	2.9	128	9.4	.4	234	2.6	.2	47	91.5	15.6	33	9.1	.8
September	104	56.7	3.3	131	2.3	0	178	1.1	.1	22	72.7	4.8	44	20.4	1.7
October	133	47.4	1.9	141	2.1	0	264	.8	0	40	62.5	4.4	80	6.3	.5
November	78	50.0	2.1	124	3.2	0	147	.7	0	44	61.4	1.9	38	5.3	.2
December	113	29.2	.7	120	6.7	.2	166	.6	0	112	42.8	1.5	54	0	0
1948															
January	114	19.3	.6	114	4.4	.1	147	0	0	63	22.2	.5	52	0	0
February	94	11.7	.2	118	0	0	161	0	0	88	17.0	.6	49	0	0
March	185	16.8	.4	213	3.3	0	163	0	0	78	16.7	.4	76	0	0
April	51	33.3	.9	233	10.7	.9	179	1.1	0	43	18.6	.5	62	1.6	0
Total May 1947–April 1948	1,494	40.6	2.6	1,697	5.6	.2	2,267	1.8	.1	676	43.3	3.4	583	4.1	.3

[1] No *R. norvegicus* were collected from Brooks County until November 1947–April 1948, when 49 were trapped with no *X. cheopis* infestation, 10.2 percent infested with *L. segnis*, no *L. bacoti* infestation and 44.9 percent infested with *P. spinulosa*.

[2] Grady County untreated; Thomas County treated with five cycles of DDT dusting between May 13, 1946 and July 30, 1947; Brooks County treated with five cycles of DDT dusting between April 1, 1946 and September 30, 1947.

[3] Sampling methods used in collecting the preliminary data were not strictly comparable between counties or with subsequent methods.

the serum of which yielded positive typhus complement-fixation results, was higher prior to dusting operations, and through May and June 1946, in Thomas and Brooks Counties than in Grady County, which was not treated. During and after July 1946, the percentage of positive *R. rattus* in Brooks County and *R. norvegicus* in Thomas County was consistently less than in the untreated county. The percentage of positive *R. rattus* remained higher in Thomas County until October 1946, when the prevalence of positive reactors dropped below, and remained below, the prevalence level of that in the untreated county (Grady). A more prompt reduction of positive rats in Brooks than in Thomas County was attributed, at least in part, to the earlier start in dusting operations in Brooks County. Trends continued in a generally downward direction in the treated counties to the end of the report period (April 1948).

Ectoparasite Findings—During the period, May 1946 through April 1948, more than 96 percent of the total number of ectoparasites collected in the three counties was among four species. They were the oriental rat flea, *Xenopsylla cheopis* (Rothschild), (10.6 percent); mouse flea, *Leptopsylla segnis* (Schönherr), (6.1 percent); tropical rat mite, *Liponyssus bacoti* (Hirst), (27.3 percent); common rat louse, *Polyplax spinulosa* (Burmeister), (52.1 percent). In untreated Grady County, 16.3 percent of the ectoparasites collected were *X. cheopis*, 9.8 percent were *L. segnis*, 25.0 percent were *L. bacoti* and 44.6 percent were *P. spinulosa.*

Differences in ectoparasite rates on the two species of hosts must be interpreted with caution, since larger numbers of *R. rattus* were collected than *R. norvegicus* in all three counties but not in the same proportion (tables 5, 6, 7, 8). The monthly figures for percentage of rats infested fluctuated less erratically than did the figures for mean number of ectoparasites per rat.

Although some reduction in flea infestation rates occurred in the untreated county as the study progressed, the much greater reduction in dusted counties gave evidence of control of *X. cheopis* and *L. segnis* by dusting operations (figures and tables 5 and 6). This was particularly evident when the ectoparasite data, collected prior to May 1946, were included in the analyses of flea infestation trends. The earlier and more effective control of these fleas in Brooks County than in Thomas County was probably attributable to the 6 weeks' earlier start of dusting operations in Brooks County. It appeared that during the fourth and fifth DDT dusting cycles in April–May and August–September 1947, respectively, more effective control of fleas was obtained in Brooks County than by similar operations in Thomas County, timed in February–March and June–July. It should be noted that DDT dusting operations in these two counties during 1946

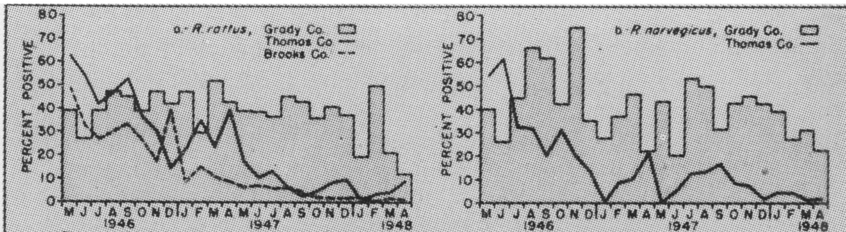


Figure 4.-Percent of rats with murine typhus complement fixing antibodies.¹/

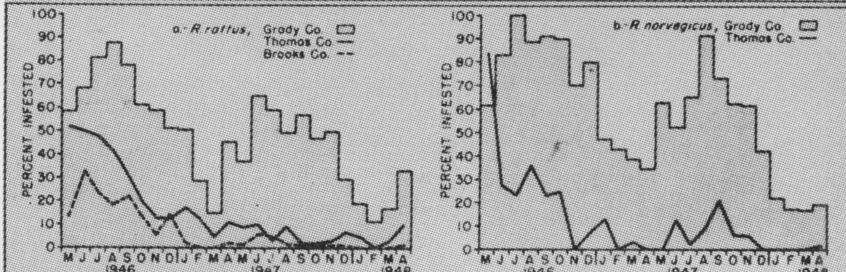


Figure 5.-Percent of rats infested with *Xenopsylla cheopis*.¹/

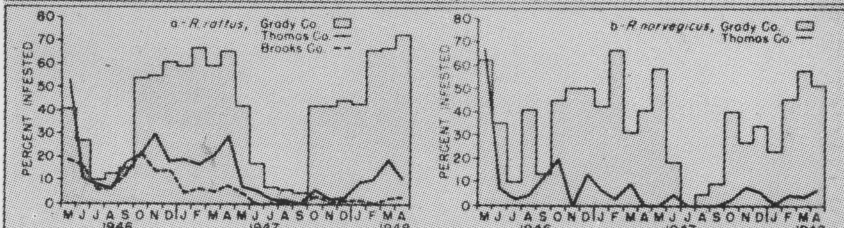


Figure 6.-Percent of rats infested with *Leptopsylla segnis*.¹/

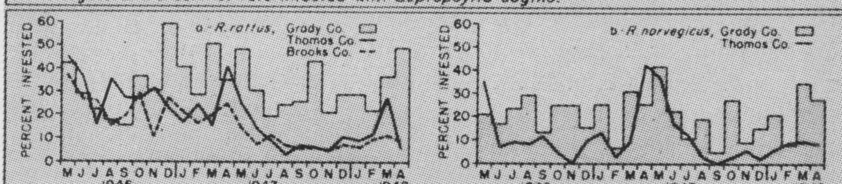


Figure 7.-Percent of rats infested with *Liponyssus bacoti*.¹/

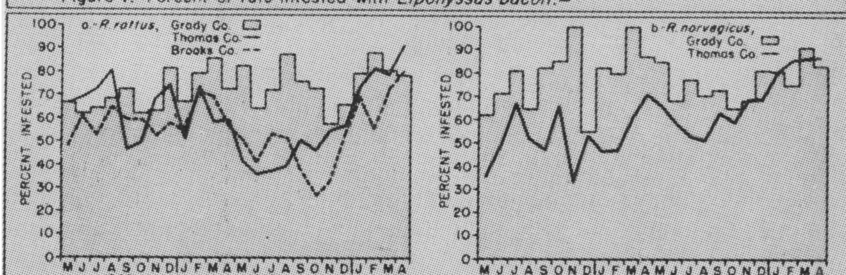
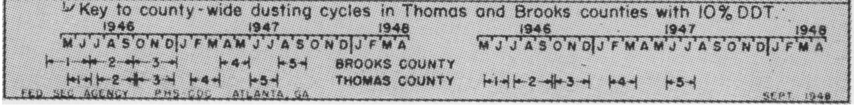


Figure 8.-Percent of rats infested with *Polyplax spinulosa*.¹/

¹/ Key to county-wide dusting cycles in Thomas and Brooks counties with 10% DDT.



were not identical in all respects, which might have accounted for the differences noted in the results obtained during 1947.

The percentage of rats infested with *L. bacoti* was slightly reduced through the cumulative effect of repeated DDT dusting cycles (figure 7; table 7). Immediate or marked control of this mite was not apparent. There was very little evidence of practical control of *P. spinulosa* on rats

Table 6. **Leptopsylla segnis** ***infestation of*** **Rattus rattus** ***and*** **Rattus norvegicus** ***in Grady, Thomas, and Brooks Counties, Georgia, by months, in the evaluation of DDT dusting operations*** [1]

Month	*Rattus rattus*						*Rattus norvegicus* [2]			
	Grady County [3]		Thomas County [3]		Brooks County [3]		Grady County [3]		Thomas County [3]	
	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat
Preliminary data: [4]										
October-December 1945	------	------	33.9	1.5	32.2	1.1	------	------	0	0
January-March 1946	------	------	71.2	6.2	65.4	4.6	------	------	0	0
April 1946	64.7	3.4	77.9	5.6	54.5	5.1	100.0	10.0	0	0
1946										
May	40.5	1.5	53.0	2.0	18.7	.6	62.1	3.4	67.7	7.4
June	27.0	1.0	10.6	.2	15.9	.7	35.7	1.1	7.0	.2
July	9.9	.1	8.0	.1	6.4	.3	9.5	.1	2.9	0
August	13.0	.2	6.7	.1	6.7	.2	41.2	1.2	4.0	.3
September	15.5	.2	18.0	.8	12.3	.2	13.0	.2	11.8	.2
October	51.2	2.6	21.3	1.2	21.9	.8	45.0	4.4	20.0	1.7
November	55.1	4.3	29.8	1.4	14.3	.6	50.0	3.3	0	0
December	61.1	2.8	17.9	.7	14.0	.3	50.0	4.5	13.3	.7
1947										
January	59.5	5.5	19.4	1.1	4.6	.1	42.8	3.2	6.7	.1
February	67.3	4.6	16.9	.5	7.6	.2	66.7	2.6	2.9	0
March	59.7	3.9	20.4	.8	5.1	.1	30.8	1.9	9.1	.4
April	65.6	5.3	29.4	2.0	7.9	.3	40.4	6.1	0	0
Total May 1946-April 1947	41.6	2.5	22.8	1.0	11.7	.4	41.8	2.9	14.1	1.1
1947										
May	42.0	2.6	7.6	.4	4.1	.1	58.7	3.4	0	0
June	17.1	.4	5.1	.1	0	0	18.2	.7	4.2	0
July	7.4	.3	1.6	0	0	0	0	0	0	0
August	6.1	.1	.8	0	.4	0	4.2	0	0	0
September	4.8	.1	0	0	0	0	9.1	.2	0	0
October	42.1	1.9	5.7	.1	3.4	.1	40.0	1.6	2.5	.1
November	42.3	1.7	1.6	0	.7	0	27.3	.9	7.9	.3
December	44.2	2.4	2.5	.2	1.2	0	33.9	2.0	5.6	.1
1948										
January	43.0	2.2	9.6	.2	1.4	.2	23.8	.7	0	0
February	66.0	3.8	10.2	.2	0	0	45.4	1.6	4.1	.4
March	67.0	5.2	18.8	.9	1.8	.1	57.7	7.0	3.9	0
April	72.5	3.4	10.3	.3	2.8	0	51.2	5.2	6.4	.2
Total May 1947-April 1948	34.9	2.0	7.0	.2	1.4	0	33.6	2.2	3.1	.1

[1] The numbers of rats examined are shown in table 5.
[2] No *Rattus norvegicus* were collected from Brooks County until the period November 1947-April 1948, when 49 were trapped with no *X. cheopis* infestation, with 10.2 percent infested with *L. segnis*, with no *L. bacoti* infestation and with 44.9 percent infested with *P. spinulosa*.
[3] Grady County untreated; Thomas County treated with 5 cycles of DDT dusting between May 13, 1946, and July 30, 1947; Brooks County treated with 5 cycles of DDT dusting between Apr. 1, 1946, and Sept. 30, 1947.
[4] Sampling methods used in collecting the preliminary data were not strictly comparable between counties or with subsequent methods.

from the dusted counties (figure 8; table 8). This louse spends its entire life cycle on its host; it therefore has less chance of coming in contact with and obtaining a lethal dose of DDT than do the fleas and mites which normally spend a portion of their time off the host animal, in rat runs and harborages where the DDT is distributed.

The sticktight flea, *Echidnophaga gallinacea* (Westwood), comprised

Table 7. **Liponyssus bacoti** ***infestation of*** **Rattus rattus** ***and*** **Rattus norvegicus** ***in Grady, Thomas and Brooks Counties, Georgia, by months, in the evaluation of DDT dusting operations*** [1]

Month	*Rattus rattus*						*Rattus norvegicus* [2]			
	Grady County [3]		Thomas County [3]		Brooks County [3]		Grady County [3]		Thomas County [3]	
	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat
Preliminary data: [4]										
October-December 1945	------	------	**30.2**	1.7	**49.1**	5.6	------	------	**25.0**	1.25
January-March 1946	------	------	**71.9**	11.7	**58.2**	13.6	------	------	------	------
April 1946	**50.0**	9.3	**61.9**	7.1	**60.5**	9.0	------	------	------	------
1946										
May	**42.2**	6.4	**45.1**	5.4	**36.5**	4.4	**20.7**	1.9	**35.5**	2.4
June	**29.7**	3.1	**36.5**	3.9	**27.3**	4.8	**16.7**	1.9	**7.0**	.7
July	**22.3**	3.8	**15.9**	1.1	**26.1**	9.1	**23.8**	.3	**8.8**	.7
August	**17.4**	8.5	**35.6**	6.1	**15.8**	1.0	**29.4**	2.0	**8.0**	.4
September	**15.5**	2.2	**27.9**	8.2	**19.6**	1.1	**13.0**	3.2	**11.8**	.2
October	**36.4**	5.8	**27.6**	10.1	**29.6**	15.3	**25.0**	1.1	**4.4**	.8
November	**30.6**	5.9	**31.9**	6.6	**10.7**	12.9	**25.0**	8.2	**0**	0
December	**59.2**	5.7	**23.1**	16.0	**27.2**	9.0	**15.0**	.6	**10.0**	1.7
1947										
January	**40.5**	18.0	**16.3**	14.2	**21.1**	7.7	**25.7**	1.2	**13.3**	.2
February	**28.6**	1.4	**24.6**	1.4	**16.1**	1.1	**6.7**	.1	**2.9**	0
March	**50.6**	3.3	**15.7**	1.0	**19.6**	2.7	**30.8**	.3	**9.1**	.2
April	**35.1**	4.3	**41.1**	2.9	**25.0**	14.9	**25.5**	4.0	**42.8**	2.4
Total May 1946-April 1947	**33.2**	6.0	**30.9**	6.0	**24.1**	7.3	**21.3**	2.0	**11.6**	.8
1947										
May	**48.2**	12.1	**25.4**	10.2	**14.4**	3.0	**41.3**	3.7	**36.7**	1.9
June	**30.8**	5.6	**14.0**	1.2	**7.6**	.4	**22.7**	.9	**16.7**	.5
July	**19.1**	2.1	**9.1**	1.5	**11.6**	1.4	**10.2**	.1	**12.2**	2.0
August	**24.5**	5.1	**3.1**	.1	**7.3**	.4	**19.1**	.4	**3.0**	0
September	**26.0**	2.4	**6.9**	.8	**5.6**	.8	**4.5**	.1	**0**	0
October	**43.6**	44.2	**5.7**	1.0	**5.7**	.6	**27.5**	3.7	**2.5**	.1
November	**20.5**	2.9	**4.8**	1.1	**4.8**	.2	**9.1**	.1	**5.3**	.1
December	**29.2**	6.5	**10.8**	.3	**7.2**	3.1	**15.2**	.8	**1.8**	.1
1948										
January	**28.9**	4.5	**3.8**	1.3	**6.1**	.2	**20.6**	.5	**5.8**	.8
February	**22.3**	3.1	**11.9**	.4	**9.3**	2.3	**8.0**	2.0	**8.2**	.1
March	**36.2**	3.6	**27.7**	8.8	**11.6**	.7	**34.6**	5.5	**9.2**	.7
April	**49.0**	5.2	**5.6**	.7	**8.9**	.3	**27.9**	1.6	**8.1**	.1
Total May 1947-April 1948	**30.9**	8.3	**11.5**	2.5	**8.4**	1.1	**20.0**	1.8	**7.7**	.5

[1] The numbers of rats examined are shown in table 5.
[2] No *Rattus norvegicus* were collected from Brooks County until the period November 1947-April 1948, when 49 were trapped with no *X. cheopis* infestation, with 10.2 percent infested with *L. segnis*, with no *L. bacoti* infestation and with 44.9 percent infested with *P. spinulosa*.
[3] Grady County untreated; Thomas County treated with five cycles of DDT dusting between May 13, 1946 and July 30, 1947; Brooks County treated with five cycles of DDT dusting between Apr. 1, 1946 and Sept. 30, 1947.
[4] Sampling methods used in collecting the preliminary data were not strictly comparable between counties or with subsequent methods.

2.7 percent of the total ectoparasite collection from the three counties; 3.6 percent of the Grady County collection. This flea was encountered much more frequently on *Rattus norvegicus* than on *Rattus rattus*. In the untreated area, from 15 to 40 percent of the Norway rats were infested during most of the year, with over 5 percent infested during February at the lowest point of seasonal abundance. While infesta-

Table 8. *Polyplax spinulosa* ***infestation of*** *Rattus rattus* ***and*** *Rattus norvegicus* ***in Grady, Thomas and Brooks Counties, Georgia, by months, in the evaluation of DDT dusting operations*** [1]

Month	*Rattus rattus*						*Rattus norvegicus* [2]			
	Grady County [3]		Thomas County [3]		Brooks County [3]		Grady County [3]		Thomas County [3]	
	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number per rat	Percent infested	Mean number Per rat	Percent infested	Mean number Per rat
Preliminary data: [4]										
October–December 1945	------	------	61.4	3.6	55.5	4.7	------	------	25.0	0.2
January–March 1946	------	------	66.2	7.7	65.7	7.4	------	------	------	------
April 1946	51.9	3.8	63.7	4.4	54.5	4.6	50.0	6.5	------	------
1946										
May	67.2	6.5	67.2	4.4	48.3	3.3	62.1	23.6	35.5	2.5
June	62.2	5.9	69.2	5.1	60.8	4.7	71.4	20.2	48.8	6.7
July	64.5	6.7	72.7	7.5	52.6	8.8	81.0	9.6	67.5	5.0
August	68.5	7.5	80.8	12.8	64.6	6.2	64.7	16.2	52.0	14.0
September	72.2	6.8	46.7	4.6	59.4	5.0	82.6	6.2	47.0	3.6
October	61.9	7.4	49.4	4.3	59.7	4.4	85.0	7.6	66.7	11.8
November	63.3	6.0	68.1	8.4	52.7	4.8	100.0	12.6	33.3	1.0
December	81.5	63.2	74.4	7.9	57.9	7.7	55.0	180.6	53.3	7.8
1947										
January	67.5	4.8	51.0	3.1	53.2	5.9	82.8	7.4	46.7	3.1
February	79.6	11.7	73.8	10.0	72.0	7.4	80.0	5.3	47.0	8.1
March	85.7	6.8	58.3	8.7	69.0	11.0	100.0	3.9	60.6	5.5
April	72.5	4.4	59.6	4.3	56.9	6.1	87.2	11.7	71.4	5.6
Total May 1946–April 1947	69.1	9.0	62.9	6.1	58.5	6.2	79.3	21.2	54.1	7.0
1947										
May	82.5	6.8	41.5	2.9	50.2	4.2	84.8	13.3	66.7	12.9
June	64.1	4.4	36.0	2.0	41.4	2.4	68.2	10.8	58.3	21.9
July	72.1	7.8	37.2	1.8	53.4	3.9	77.6	5.9	53.6	5.4
August	87.8	7.8	39.1	2.6	51.3	3.4	70.2	7.1	51.5	3.8
September	76.0	8.8	50.4	3.3	38.8	2.3	72.7	4.4	63.6	4.4
October	72.9	4.9	46.1	3.3	26.9	1.6	65.0	6.5	58.8	19.2
November	57.7	4.6	55.6	4.0	32.6	3.0	68.2	9.3	68.4	4.9
December	66.4	5.8	56.7	9.1	55.4	12.0	81.2	7.7	68.5	4.8
1948										
January	79.8	10.9	73.7	24.8	69.4	9.0	81.0	27.2	80.8	25.7
February	88.3	10.5	81.4	10.1	55.9	8.9	75.0	8.4	85.7	10.5
March	80.5	10.7	79.3	10.4	72.4	9.4	91.0	28.2	86.8	33.6
April	78.4	11.2	91.8	13.7	80.4	24.9	83.7	11.1	87.1	11.5
Total May 1947–April 1948	76.0	7.8	60.3	7.7	51.1	6.6	78.0	12.5	71.2	14.7

[1] The numbers of rats examined are shown in table 5.
[2] No *Rattus norvegicus* were collected from Brooks County until the period November 1947–April 1948, when 49 were trapped with no *X. cheopis* infestation, with 10.2 percent infested with *L. segnis*, with no *L. bacoti* infestation and with 44.9 percent infested with *P. spinulosa*.
[3] Grady County untreated; Thomas County treated with five cycles of DDT dusting between May 13, 1946 and July 30, 1947; Brooks County treated with five cycles of DDT dusting between Apr. 1, 1946 and Sept. 30, 1947.
[4] Sampling methods used in collecting the preliminary data were not strictly comparable between counties or with subsequent methods.

tion of rats with the sticktight flea was definitely suppressed in the dusted counties, its control was erratic in contrast to the more consistent reduction of *X. cheopis* and *L. segnis*. This erratic control of *E. gallinacea*, a common ectoparasite of domestic fowls, may be partly attributed to the particular care taken to avoid DDT dusting which might endanger chickens.

The reduction in population of ectoparasites in dusted counties was not necessarily the sole cause of the downward trends in human incidence of murine typhus fever, and in the prevalence of rats which were positive to the murine typhus complement fixation test. Field observations and rat colony experience indicated that toxic effects, similar to those seen in laboratory experiments on rats, occurred following DDT dusting operations (*8*). Although there was no way of knowing the degree of rat mortality occasioned by county-wide DDT dusting operations, some rat deaths were attributable to this cause. In addition, various other disturbances in rat habits were noted, including a general exodus of rats from a heavily infested area immediately following the first application of DDT dust. Such factors may have contributed to the decline in murine typhus observed in man and rat (*9, 10*).

Summary

In an area where the probability of rural residents acquiring murine typhus fever was equal to or greater than that for urban residents, it was found possible to control this disease on a county-wide basis.

By the county-wide application of 10 percent DDT in pyrophyllite to rat runs and harborages and in the absence of other rodent, rodent ectoparasite, or typhus control measures, human murine typhus fever incidence was significantly reduced in Thomas and Brooks counties, Georgia, as was shown by comparison with previous experience in these counties and by concurrent comparisons with data from untreated Grady County.

DDT dusting operations, as executed, disturbed the normal ecology of rat and rat ectoparasite populations in a variety of ways and by so doing may have contributed to the altered epidemiological picture of murine typhus fever.

A significant reduction in the prevalence of typhus complement fixing antibodies in the rat populations of the dusted counties closely followed and was attributed to the ectoparasite control obtained.

In contrast with levels observed in an untreated county, satisfactory county-wide control of *Xenopsylla cheopis* and *Leptopsylla segnis* was obtained by the county-wide DDT dusting operations.

Liponyssus bacoti and *Polyplax spinulosa* populations on rats were reduced only slightly in the treated counties.

ACKNOWLEDGMENTS

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Attempt to Produce an Arsenic-Resistant Strain of *Spirochaeta pallida* in Experimental Syphilis

By T. F. PROBEY, *Senior Pharmacologist* [1]

Although much has been written about "treatment-resistant syphilis," there is no generally accepted explanation of this phenomenon. It is the concensus that the cause lies in one of three factors—the host, the drug, or the *Spirochaeta pallida* (*1*).

One theory is that the action of the drug on the spirochete produces a drug-resistant strain of *S. pallida.* This explanation of treatment-resistant syphilis has considerable support, but is not accepted by all authorities. Other clinicians admit the possibility of the spirochete becoming resistant to a single drug but not to all. The production of a drug-resistant strain of *S. pallida* is possible, it is argued, because of the necessarily prolonged subjection of the organism to repeated and continuous subcurative (substerilizing) doses.

With the introduction of arsenic in the therapy of syphilis, the possibility of "arsenic-resistant" strains of *S. pallida* was accepted since arsenic was known to induce "arsenic-resistance" or "tolerance." Cases of early relapse because of inadequate therapy, especially in the early days when Ehrlich's therapia sterilisans magna was accepted as the best method of treatment, did much to contribute to the acceptance of "arsenic-resistant" strains of *S. pallida.*

Reviews by Yorke (*2*) in 1933, Beerman (*1*) in 1936, and Beerman and Severac (*3*) in 1942 give a comprehensive coverage of the literature on treatment-resistant syphilis. Yorke (*2*) reported that a critical examination of studies by workers who claim to have succeeded in enhancing the resistance of *S. pallida* shows that the increased resistance was comparatively slight. In his summary, Yorke observed that although there is some evidence that drug-resistant strains of *S. pallida* may be produced, it is a much more difficult matter than in the case of trypanosomes. Beerman (*1*) in his summary reports that while a few of the early experimental studies indicate that treatment resistance could not be induced experimentally by subcurative doses of drugs, other of the early studies and practically all recent investigations show that resistance to drugs can be provoked by exposing *S. pallida* to inadequate doses. Beerman and Severac report (*3*) that many investigators have inoculated animals with organisms from treatment-resistant patients, and all, except Schoch and also Beerman, found that the strains of *S. pallida* isolated from treatment-resistant human cases were apparently not treatment-resistant in rabbits. Most of these investigations, they point out, were of short

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duration, and the criteria used in the study of experimental syphilis in rabbits were unreliable.

Critical examination of these studies shows not only that the increased resistance was comparatively slight (*2*) but also that some studies were not conducted with *S. pallida;* that one report was designed to study the influence of subcurative doses of arsenicals on the resistance of infected rabbits to reinfection; that another was evaluated on the basis of the therapeutic dose and not on the curative dose in experimental syphilis, and that one was an *in vitro* study. Beerman (*1*) and Beerman and Severac (*3*) have presented a study of a strain of *S. pallida* recovered from a case of treatment-resistant syphilis. Their experiments, to determine the therapeutic efficacy of arsphenamine in the syphilitic infection with the "resistant" strain, were controlled by rabbits infected with the Nichols strain. The curative dose of arsphenamine for rabbits infected with the Nichols strain, Beerman reported, was 14 mg. per kg. This report is an account of experiments with 18 rabbits conducted over the 10-year period, 1924 to 1934. Beerman and Severac reported that in a series of experiments conducted over a period of 9 years, 1933–1941 (including Beerman's study (*1*)), 13 of 51 rabbits infected with the resistant strain and treated with arsphenamine with doses from 14 to 30 mg. per kg. were not cured. However, a break-down of their table shows that treatment with 18 mg., 20 mg., and 25 mg. of arsphenamine cured 86 percent, 80 percent, and 89 percent, respectively, of the infected rabbits.

The results (*3*) indicate that a strain of *S. pallida* has been found which in rabbits has sporadically exhibited evidence of refractoriness to treatment. This refractoriness becomes quantitatively less as the strain becomes more adapted to the new host. This was indicated by the increasing difficulty of finding infected rabbits whose syphilis resisted treatment with doses of arsphenamine significantly higher than the usual sterilizing dose.

Studies in experimental syphilis by Pearce (*4*) have demonstrated that the infection with *S. pallida* varies within rather wide limits from time to time, but values are relatively constant for any strain at a given time. This would mean that the experimental syphilitic infection varies from animal passage to animal passage, but in the same passage the infection is relatively constant. It was our experience, in a study of the spirocheticidal activity of neoarsphenamine (*5*), that the minimal effective dose varied from test to test, probably because of the variable factors in the experimental infection rather than differences in the curative activity of the drug. It was also our observation that, because of this variation in the curative dose 25 mg. to 40 mg. per kg., each test must be considered independently and must be compared with a control product. With this procedure no significant difference in the sterilizing power of neoarsphenamine could be noted.

Experimental attempts to produce a "resistant" strain of *S. pallida* have given unconvincing results, and critical examination of the reports of workers claiming to have enhanced the resistance of *S. pallida* shows that the increased resistance is comparatively slight (*2*). In fact, the more probable explanation is that the reported variation is due to the normal variation in the experimental syphilitic infection in rabbits rather than to an increased resistance of *S. pallida* to arsenic.

"Arsenic resistance," "treatment resistance," or "Wassermann fastness" are terms employed to describe a condition in the management of clinical syphilis. There is, however, no clear-cut clinical criterion by which "arsenic resistant" strains of *S. pallida* can be identified. Consequently, studies of experimental syphilis in rabbits offer the only method of identifying a strain of *S. pallida* that has acquired "arsenic tolerance" or "resistance" or, conversely, a strain that does not become arsenic resistant. This information would be definite only as regards *S. pallida* which has become adapted to the rabbit host and not necessarily applicable to *S. pallida* in human infection.

Experimental Study and Observations

In this study an attempt was made to induce "arsenic resistance" in the Nichols strain of *S. pallida* in experimental syphilis by subcurative treatment with neoarsphenamine.

The "resistant strain" was started with two rabbits from series 5 of the study of the spirocheticidal activity of neoarsphenamine (*5*). The rabbits were infected with the normal strain of *S. pallida* on September 22, 1933. They developed darkfield positive lesions and were treated with 20 mg. per kg. of neoarsphenamine D4 on December 7, 1933. Both rabbits were killed on May 16, 1934, and tissue transfers were made to normal rabbits. The transfer rabbits developed darkfield positive lesions. The sterilizing dose of the several lots of neoarsphenamine reported in series 5 was recorded as 30 mg. per kg.

Theoretically, arsenic resistance of *S. pallida* is produced either by a large subcurative dose, or by multiple small doses of arsenic (*1*). The treatment schedules employed both procedures. In each of three passages (numbers 1, 3, and 6) the treatment employed was a single injection of 20 mg. of neoarsphenamine per kg. This dose we have found to be a relatively large subcurative dose, curing 45 of 126 rabbits, or 35.7 percent (*5,6*). In five passages (numbers 7, 8, 10, 11, and 15) the strain was subjected to weekly injections of 1 mg. per kg. of neoarsphenamine. The course of treatment used in these passages, especially in passage 8 with 52 weekly injections, should satisfy the multiple-small-dose theory for the production of arsenic resistance.

The "resistant strain" has been carried through 24 rabbit passages.

The history of the strain passages and the treatments with neoarsphenamine are detailed in table 1. It will be noted that 6 animal passages have been dropped from the table. In several of these passages the treatment schedule employed cured the infection, and it was necessary to use the untreated controls of that passage, or the previous passage, to carry the "resistant strain."

The rabbits infected with the normal strain of *S. pallida* were used as controls. These infections naturally were not from the same animal passage as those used to infect the rabbits with the "resistant" strain; the two strains may differ in either or both tests because, as reported by Pearce (*4*), the infectivity of *S. pallida* may vary within wide limits from passage to passage.

Table 1. ***History of strain passages (transfers) and treatment with neoarsphenamine***

Strain passage	Treatment		Strain passage	Treatment	
	Number	Dose mg./kg.		Number	Dose mg./kg.
Normal	1	20	12 RS	*25	1
1 RS	None		15 RS	*12	1
2 RS	1	20	17 RS	None	
3 RS	None		18 RS	None	
4 RS	None		20 RS	None	
5 RS	1	20	21 RS	*12	1
6 RS	*15	1	22 RS	None	
7 RS	*52	1	23 RS	1	20
8 RS	None				

*1 milligram dose at weekly intervals.

NOTE: See table 2 for arsenic resistance tests.

The technique used in this study is the same as that employed in the study of the spirocheticidal activity of arsenicals (*5*). The criterion of cure or of the presence of syphilitic infection was established by tissue transfers from the testicles and the popliteal glands to normal rabbits. In the second test to determine "arsenic resistance," the transfer rabbits were subjected also to the reinoculation test.

Table 2 details the results of the two tests to determine whether the strain had become "arsenic resistant," and the control tests with the normal strain of *S. pallida*.

The "resistant strain" was tested the first time at the third animal passage, the second passage as the "resistant strain" (2 RS.), with one previous treatment with 20 mg. per kg. of neoarsphenamine. The experimental syphilitic infection with the "resistant strain" was cured; that is, all of 7 rabbits, with 40 mg. per kg. of neoarsphenamine, and 4 of 7 rabbits with 30 mg. per kg. The 20 mg. dose was ineffective. The control group, infected with the normal strain of *S. pallida*, was cured; that is, all of 7 rabbits, with 30 mg. per kg. of neoarsphenamine, and 6 of 7 rabbits were cured with 25 mg., and 2 of 7 rabbits with 20 mg. per kg. The same lot of neoarsphenamine was used for the treatment of both groups of rabbits.

The second test to determine "arsenic resistance" was conducted at the twenty-fourth animal passage, the twenty-third of the "resistant strain" (23 RS.). Previous treatment has consisted of 3 single injections of 20 mg. per kg. and 116 injections of 1 mg. per kg., a total of 176 mg. per kg. of neoarsphenamine. Because of the extensive treatment to which the "resistant strain" had been subjected, it was decided to alter the dose schedule used in the first test to include a higher dose level in the event that the strain had become resistant. The number of rabbits in both "resistant" and control groups was increased to 10 with every dose to minimize the probable error of small numbers of test animals.

Table 2. ***Effect of subcurative treatment with neoarsphenamine on*** S. pallida—***"arsenic resistance" in experimental syphilis in rabbits***

S. pallida	Results of tissue transfer from rabbits treated with neoarsphenamine. Dose per kg.										Minimal effective dose	Observation periods			Remarks
	80 mg.		40 mg.		30 mg.		25 mg.		20 mg.			Pre-treatment	Post-treatment	Transfer	
	+	−	+	−	+	−	+	−	+	−					
											mg.	*Weeks*	*Weeks*	*Weeks*	
Nichols strain	----	----	----	----	1	3	1	4	[1] 4	1	30	11	23	19	D4 series 5.[2]
Resistant strain 2 RS).	----	----	0	7	3	4	----	----	[3] 2	6	40	10	18	20	
Nichols strain (control).	----	----	----	----	0	7	1	5	5	2	25	10	13	18	A4 series 6.[2]
Resistant strain (23 RS).	0	[4,5] 6	0	[4] 10	----	----	----	----	10	0	<40	7	14	30	
Nichols strain (control).	----	----	0	[4] 10	----	----	----	----	----	----	<40	7	14	30	
Composite resistant strain.	0	6	0	17	3	4	----	----	12	0	40	----	----	----	
Nichols strain	----	----	7	81	35	106	22	60	81	45	25-40	----	----	----	Series 1 to 14.[2].

[1] Origin of the "resistant" strain.
[2] References (*5, 6*).
[3] Each rabbit inoculated with tissue pool of 3 rabbits.
[4] Reinoculation test—all rabbits developed syphilis.
[5] 4 rabbits died 24th to 32d day after treatment.

The experimental infection with the "resistant strain" was cured with both 80 mg. and 40 mg. per kg. of neoarsphenamine; with 20 mg. none of the 10 rabbits was cured. All 10 rabbits of the control group infected with the normal strain were cured with 40 mg. per kg. of the same lot of neoarsphenamine. Because all rabbits of the "resistant" group at the two higher-dose levels and all rabbits of the control group at the one-dose level were apparently cured of the experimental infection, it was deemed advisable to subject the transfer rabbits of these three groups to reinoculation with *S. pallida* to eliminate the possibility of the presence of asymptomatic syphilis. The untreated strain controls of both groups (rabbits infected to carry the strains) were also reinoculated as controls for the reinoculation test. All transfer rabbits from the three treated groups subsequent to reinoculation developed darkfield-positive lesions. The strain-control groups with history of having had primary lesions remained negative.

In the composite protocol, table 2, the results of the two tests with the "resistant" strain and the results of previously reported study of the spirocheticidal (normal strain) activity of arsenicals (*6*), are detailed for the purpose of comparing the efficacy of neoarsphenamine in experimental syphilis in rabbits infected with the "arsenic-resistant" strain and with the normal strain of *S. pallida*.

The difference in the effective dose of neoarsphenamine in curing experimental syphilis in rabbits infected with "arsenic-resistant" strain and normal strain, 40 mg. and 30 mg. per kg., is well within the limits of variation reported (*6*) for neoarsphenamine, 25 to 40 mg. per kg. in curing experimental syphilis. This variation probably was due to the variable factors in the experimental infection rather than to differences in the curative activity of neoarsphenamine.

An interesting sidelight in the study is the fact that the only deaths occurring in the syphilitic rabbits following therapy were those in the group receiving 80 mg. per kg. of neoarsphenamine in the second test for "resistance." Of the 10 syphilitic rabbits receiving this dose, 4 died between the 24th and 32d days after treatment. These deaths may be an indication of the toxicity of arsenic to syphilitic rabbits; however, we are unable to eliminate the possibility of an intercurrent infection as the cause of death as these rabbits, although individually caged, were in the same battery of cages.

Conclusion

The Nichols strain of *S. pallida* in experimental syphilis in rabbits was not rendered "arsenic resistant" by the sub-curative treatment schedule employed in this study: (1) large single dose and (2) multiple small doses of neoarsphenamine.

The variation between the curative dose of neoarsphenamine in the experimental infection with the "resistant" strain and the normal strain, 40 mg. and 30 mg. per kg., respectively, is within the limits expected in experimental infection.

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Examination for Medical Officers

A competitive examination will be held January 17, 18, and 19, 1949, for appointment of medical officers in the Regular Corps of the Public Health Service in the grades of assistant surgeon (1st lieutenant) and senior assistant surgeon (captain).

The Regular Corps is a commissioned officer corps composed of members of various medical and scientific professions, appointed in appropriate professional categories such as medical, dental, nursing, engineering, pharmacy, etc., depending on training and experience.

Requirements. For the assistant surgeon appointment the applicant must be a United States citizen, at least 21 years of age, and a graduate from a recognized school of medicine. Physicians now serving internships, who are successful on the examination, will not be placed on active duty in the Regular Corps until completion of internship. Senior assistant surgeon applicants in addition to the above requirements, must have at least 10 years of educational training and professional experience subsequent to high school. (All commissioned officers are appointed to the general service and are subject to change of station.) Qualifying applicants will receive written professional tests, an oral interview, and a physical examination.

The professional written examination for assistant surgeon will cover: (1) anatomy, physiology, bio-chemistry; (2) materia medica and therapeutics; (3) practice of medicine; (4) practice of surgery; (5) obstetrics and gynecology; (6) epidemiology and hygiene; (7) pathology and bacteriology. Senior assistant surgeon applicants will be examined on subjects 3, 4, 6, and 7 listed above.

Examinations will be held at Norfolk, New Orleans, San Francisco, Seattle, Chicago, Cleveland, Detroit, Boston, Memphis, Kirkwood (Missouri), Staten Island, Los Angeles, Lexington (Kentucky), Fort Worth, Kansas City (Missouri), Denver, and Atlanta.

Entrance pay for an assistant surgeon with dependents is $5,011 per annum; for senior assistant with dependents, $5,551. These figures include the $1,200 annual additional pay received by medical officers as well as subsistence and rental allowance. Provisions are made for promotion at regular intervals up to and including the grade of senior surgeon (Lt. colonel) and for selection for promotion to the grade of medical director (colonel) at $9,751 per annum.

Application forms and additional information may be obtained by writing to the: Surgeon General, Public Health Service, Washington 25, D. C. Attention: Division of Commissioned Officers. Completed applications must be received by January 1, 1949.

INCIDENCE 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 NOVEMBER 27, 1948

A total of 524 cases of poliomyelitis was reported for the week, as compared with 651 last week, 221 for the 5-year (1943–47) median, and 366, the largest number for a corresponding week of the past 5 years (in 1946). Only 3 States, Ohio, Iowa, and Missouri, reported an increase of as many as 5 cases, and only 5 States reported more than 16 cases, as follows (last week's figures in parentheses): California 192 (245), South Dakota 59 (65), Minnesota 27 (45), Iowa 23 (18), and New York 21 (27). The total for the year to date is 26,216, 5-year median 13,102. The total for the corresponding period in 1946 was 24,261, or 94 percent of the total for that year (25,698).

Of 2,075 cases of influenza reported (last week 2,067, 5-year median 2,404), 4 States (Virginia, South Carolina, Texas, and Arizona), reported 1,755 cases (last week 1,771). The cumulative figure since July 31 (average date of seasonal low incidence) is 23,418, as compared with a 5-year median 18,969 and 28,922, the largest corresponding figure of the past 6 years, reported in 1945.

A total of 3,763 cases of measles was reported (last week 4,036, 5-year median 1,936). Only 12 States reported more than 100 cases, and only Massachusetts (720 cases, last week 737) and Texas, (458, last week 276) reported more than 210 cases. The total since September 4, average seasonal low incidence date, is 21,539, 5-year median 12,596, and highest corresponding figure of the past 6 years, 27,847, reported in 1943.

During the week 1 case of anthrax was reported, in Washington, 2 cases of smallpox, 1 each in Oklahoma and Texas, and 5 cases of Rocky Mountain spotted fever, 2 each in North Carolina and Alabama, and 1 in Maryland. Of 26 cases of tularemia (last week 16, 5-year median 14), 5 occurred in Indiana and 3 each in North Carolina and Florida. No other State reported more than 2 cases.

Deaths registered during the week in 93 large cities in the United States totaled 8,535, as compared with 9,217 last week, 8,952 and 8,588, respectively, in the corresponding weeks of 1947 and 1946, and a 3-year (1945–47) median of 8,952. The total to date is 439,108, corresponding period last year 439,496. Infant deaths totaled 598, last week 686, 3-year median 678. The cumulative figure is 31,843, same period last year 35,171.

Telegraphic case reports from State health officers for week ended Nov. 27, 1948

(Leaders indicate that no cases were reported)

Division and State	Diphtheria	Encephalitis, infectious	Influenza	Measles	Meningitis, meningococcal	Pneumonia	Poliomyelitis	Rocky Mountain spotted fever	Scarlet fever	Smallpox	Tularemia	Typhoid and paratyphoid fever [d]	Whooping cough	Rabies in animals
NEW ENGLAND														
Maine	1		1	132		1			14				1	
New Hampshire				18					1					
Vermont				70					7			1	28	
Massachusetts	7	2		720		11	2		145				52	
Rhode Island				1	1	2			[c] 1					
Connecticut			1	43		26	1		12				8	
MIDDLE ATLANTIC														
New York	8		[b] 2	210	5	128	21		[c] 123			3	129	11
New Jersey	1		2	45	2	32	11		41			2	24	2
Pennsylvania	3		([b])	209	6		7		105		1	3	104	3
EAST NORTH CENTRAL														
Ohio	2		2	30	3	20	15		153		2		29	10
Indiana	10		28	22		19	3		39		5	2	18	13
Illinois	1	2		24	6	56	11		82			2	22	2
Michigan [a]	3			191	3	32	10		129		1		24	1
Wisconsin			7	164	2	8	13		39				30	
WEST NORTH CENTRAL														
Minnesota	2			4	1	2	27		52				3	
Iowa	2			48		1	23		27				1	
Missouri	9		4	49		10	10		23			2		
North Dakota	3	1	1	33			4		12					
South Dakota				3			59		2					
Nebraska	1		8	4		6	7		10					
Kansas	3		1	8		5	2		5			1	4	
SOUTH ATLANTIC														
Delaware				3					3					
Maryland [a]	1	1	3	136	2	21	5	1	12			1	18	
Dist. of Col.				6		6	2		7					
Virginia	14		274	76	2	44	5		27		1	3	13	
West Virginia	1		33	7	2	3	3		18			1	19	
North Carolina	13	1		61			10	2	41		3	1	4	
South Carolina	24	2	223	11		51	6		11			2	10	2
Georgia	18		8	10	1	9	4		20		2	2	2	3
Florida	16		1	41	1	11	3		4		3	3	2	3

EAST SOUTH CENTRAL														
Kentucky	5			1	5	19			39			1	7	23
Tennessee	3	1	18	30		38	2		47		2	2	5	
Alabama	20		22	22	6	27	2	2	17		2	4	9	2
Mississippi [a]	2		6	3		25	2		11			1	8	
WEST SOUTH CENTRAL														
Arkansas	2		55	28		25	1		8			2	7	4
Louisiana	2		2	1	1	29	3		6				1	
Oklahoma	2	1	43	21	1	12	3		13	1		2	1	1
Texas	19		1, 155	458	3	121	16		16	1		6	61	19
MOUNTAIN														
Montana			2	6		3	2		10				6	
Idaho	1		3	4		6	2		[c] 12				1	
Wyoming			3	30		6			3		1			
Colorado	1		37	49		14	1		8		2	1	10	
New Mexico	2		2	83		3			8			7	4	
Arizona	3		103			16	3		6			1	6	
Utah [a]	4		1	170		3	13		5		1		11	
Nevada														
PACIFIC														
Washington	2		3	187	1	2	9		23				9	
Oregon			11	119		23	9		17			1	10	
California	4		10	172	5	16	192		81			6	43	2
Total	215	11	2, 075	3, 763	59	892	524	5	1, 495	2	26	63	744	
Median, 1943–47	396	9	2, 404	1, 936	81		221	2	2, 574	5	14	59	2, 184	
Year to date, 47 weeks	8, 690	520	162, 233	572, 953	2, 946		26, 216	519	68, 690	56	873	3, 351	68, 887	
Median, 1943–47	12, 296	598	209, 166	566, 993	7, 395		13, 102	464	124, 926	324	724	4, 597	113, 691	
Seasonal low week ends	(27th) July 10		(30th) July 31	(35th) Sept. 4	(37th) Sept. 18		(11th) Mar. 20		(32d) Aug. 14	(35th) Sept. 4		(11th) Mar. 20	(39th) Oct. 2	
Since seasonal low week	4, 080		23, 418	21, 539	510		25, 866		13, 074	6		2, 878	5, 964	
Median, 1943–47	6, 032		18, 969	12, 596	900		12, 705		25, 163	47		3, 973	16, 155	

[a] Period ended earlier than Saturday.
[b] New York City and Philadelphia only, respectively.
[c] Including cases reported as streptococcal infection and septic sore throat.
[d] Including paratyphoid fever, reported separately, as follows: Vermont, 1; New York, 1; North Carolina, 1; Alabama, 1; Texas, 3; Colorado, 1; California, 2.

Alaska: Meningitis, 1; scarlet fever, 3; whooping cough, 3.
Territory of Hawaii: Measles, 180; scarlet fever, 1; whooping cough, 1.
Anthrax: Washington, 1.

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended November 6, 1948.—Cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chickenpox		21		144	321	49	89	78	309	1,011
Diphtheria			1	13	2	1				17
Dysentery, bacillary				8						8
German measles		3		1	7		2	3	2	18
Influenza		44			15					59
Measles		10	1	242	88	20	40	25	36	462
Meningitis, meningococcal				2	1	2				5
Mumps		7	41	60	111	28	15	12	52	326
Poliomyelitis		3	1	1	10		2	4	3	24
Scarlet fever		1	7	83	47	5	10	3	10	166
Tuberculosis (all forms)		8	12	81	54	17	12		29	213
Typhoid and paratyphoid fever			1	7						8
Undulant fever		1		1	1				1	4
Venereal diseases:										
Gonorrhea		14	10	104	83	16	23	45	100	395
Syphilis	3	2	10	54	49	7	5	8	23	161
Whooping cough		3		58	19	4		9		93

CUBA

Habana—Communicable diseases—5 weeks ended October 30, 1948.—During the 5 weeks ended October 30, 1948, certain communicable diseases were reported in Habana, Cuba, as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Chickenpox	1		Tuberculosis	4	2
Diphtheria	13		Typhoid fever	6	
Measles	2				

Provinces—Notifiable diseases—5 weeks ended October 30, 1948.—During the 5 weeks ended October 30, 1948, cases of certain notifiable diseases were reported in the Provinces of Cuba as follows:

Disease	Pinar del Rio	Habana [1]	Matanzas	Santa Clara	Camaguey	Oriente	Total
Cancer	8	16	11	23	2	11	71
Chickenpox						1	1
Diphtheria		16		2	2	3	23
Hookworm disease		15					15
Leprosy		2	2	1		1	6
Malaria	2	4	1	2	7	10	26
Measles		3	2				5
Pinta						1	1
Tuberculosis	4	11	8	14	15	12	64
Typhoid fever	8	16		17	4	120	165
Whooping cough		81					81

[1] Includes the city of Habana.

JAPAN

Notifiable diseases—5 weeks ended October 30, 1948, and accumulated totals for the year to date.—For the 5 weeks ended October 30, 1948, and for the year to date, certain notifiable diseases have been reported in Japan as follows:

Disease	5 weeks ended Oct. 30, 1948		Total reported for the year to date	
	Cases	Deaths	Cases	Deaths
Diphtheria	1,706	127	12,942	1,134
Dysentery, unspecified	1,228	457	14,120	3,866
Encephalitis, Japanese "B"	[1] 348	267	[1] 8,368	2,465
Gonorrhea	17,192		191,470	
Influenza	69		2,573	
Malaria	322	5	4,712	33
Measles	1,284		48,159	
Meningitis, epidemic	112	39	1,896	475
Paratyphoid fever	248	19	2,603	130
Pneumonia	3,925		98,588	
Scarlet fever	229	3	2,287	30
Smallpox	4		31	1
Syphilis	18,753		185,150	
Tuberculosis	37,487		325,217	
Typhoid fever	894	112	8,220	986
Typhus fever	3		461	33
Whooping cough	3,690		46,071	

[1] Includes suspected cases.

NOTE.—The above figures have been adjusted to include delayed and corrected reports.

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

Note.—The following reports include only items of unusual incidence or of special interest and the occurrence of these diseases, except yellow fever, in localities which had not recently reported cases. All reports of yellow fever are published currently.

A table showing the accumulated figures for these diseases for the year to date is published in the PUBLIC HEALTH REPORTS for the last Friday in each month.

Plague

Belgian Congo—Stanleyville Province.—During the week ended November 13, 1948, 2 fatal cases of plague in natives were reported west of Blukwa in Stanleyville Province, Belgian Congo, 1 case each in Bi and Tolo.

British East Africa.—Plague has been reported in British East Africa as follows: In Kenya Colony—For the week ended October 2, 1948, 1 case (in South Nyeri District), for the week ended October 30, 2 fatal cases; in Tanganyika Territory, week ended October 30, 14 cases, 10 deaths (in Central Province).

Madagascar.—During the period October 1–31, 1948, 13 cases of plague, with 12 deaths, were reported in Madagascar.

Smallpox

Belgian Congo.—During the period September 19–October 31, 1948, 576 cases of smallpox (including alastrim) were reported in Belgian Congo.

Iraq.—During the week ended November 20, 1948, 127 cases of smallpox with 2 deaths were reported in Iraq.

Peru.—Smallpox has been reported in Peru as follows: May 1–31, 1948, 568 cases; June 1–30, 402 cases.

Philippine Islands—Mindanao Island.—During the week ended November 13, 1948, 91 cases of smallpox with 18 deaths were reported in Mindanao Island in the Philippines.

Syria.—Smallpox has been reported in Syria as follows: Week ended November 6, 1948, 37 cases; week ended November 13, 62 cases.

Typhus Fever

Madagascar—Tananarive.—During the month of September 1948, 7 cases of typhus fever (murine) were reported in Tananarive, Madagascar.

Peru.—During the period June 1–30, 1948, 106 cases of typhus fever were reported in Peru.

Yellow Fever

Brazil—Bahia State.—On September 23, 1948, 1 death from yellow fever was reported in Ubaitaba County, Bahia State, Brazil.

DEATHS DURING WEEK ENDED NOVEMBER 20, 1948

[From the Weekly Mortality Index, issued by the National Office of Vital Statistics]

	Week ended Nov. 20, 1948	Corresponding week, 1947
Data for 93 large cities of the United States:		
Total deaths	9,217	9,212
Median for 3 prior years	8,951	
Total deaths, first 47 weeks of year	430,573	430,544
Deaths under 1 year of age	686	641
Median for 3 prior years	641	
Deaths under 1 year of age, first 47 weeks of year	31,245	34,525
Data from industrial insurance companies:		
Policies in force	70,806,389	67,047,497
Number of death claims	12,859	12,365
Death claims per 1,000 policies in force, annual rate	9.5	9.6
Death claims per 1,000 policies, first 47 weeks of year, annual rate	9.2	9.2