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THE CONTROL OF RAT ECTOPARASITES WITH DDT [1]

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Field studies were initiated in the early part of May 1945 to determine the effect of DDT on the various rat ectoparasites as a possible means of controlling endemic typhus fever and to develop equipment for the application of DDT. Detailed data have been collected from 11 treated establishments in the business districts of Savannah, Ga., which include 3 retail grocery stores, 2 wholesale grocery stores, 1 wholesale grocery warehouse, 2 poultry stores, 1 cafe, 1 feed store, and 1 chicken hatchery. These establishments were chosen from a considerable number of premises inspected for rat and rat ectoparasite infestations and, in general, represent premises with heavy infestations. Data also have been collected from many untreated establishments of similar types in order to evaluate the control data by establishing normal population variation throughout the study period. It should be noted that almost all of the rats trapped in these field studies were of the species *Rattus norvegicus*. Of 562 rats examined, only 6 of the species *Rattus rattus* were encountered.

FIELD METHODS

Trapping.—At each of the above-mentioned premises, traps were set before treatment, approximately 1 week following treatment and once each month thereafter. Occasionally, it was necessary to allow a time interval longer than one month between trappings because of limitations in the rat populations in certain premises.

All of the rats examined for ectoparasites in these studies were trapped in unbaited No. 0 steel traps. An adequate live sample of a rat population can be secured readily with proper use of this type of

[1] From Communicable Disease Center, Technical Development Division (Savannah, Ga.), States Relations Division.

trap. Traps were set along well-defined rat runways and at the mouths of holes and burrows after a careful inspection to locate all infestations in each establishment. The traps were scattered over the infested areas in order to randomize the samples.

The number of rats trapped from each premise before and after treatment was dependent upon the rat population present. Five to seven rats were considered to be a satisfactory sample in most premises at each trapping period. A larger sample would have been desirable from a statistical standpoint, but since it was necessary to have a rat population available throughout the study period, the samples were limited so as not to deplete the supply.

After treatment with 10-percent DDT dust, traps were set in such positions as to prevent trapped rats from contacting DDT dust after having been caught. Trap chains were nailed close to the traps themselves to limit the effective radius of the rats' movements.

Collection of ectoparasites and identification.—Rats caught alive were transferred to flea-proof rat bags (seams turned out), tagged, and taken to the laboratory. Rats and ectoparasites were killed in the secured bags by exposure to chloroform. Ectoparasites were then removed from the rats by a combination of combing and beating, allowing the ectoparasites to drop into a large, shallow, white-enameled pan from which they were readily collected. The inside of each bag was examined carefully for any parasites which may have left the host rat.

A total of five species of fleas were taken throughout the course of this study. *Xenopsylla cheopis* (Rothschild), the oriental rat flea, was by far the most predominant of these species. Other species of fleas collected were: *Nosopsyllus fasciatus* (Bosc), *Leptopsylla segnis* (Schönherr), *Echidnophaga gallinacea* (Westwood), and *Ctenocephalides felis* (Bouché).

Species of mites collected were: *Liponyssus bacoti* (Hirst), *Laelaps hawaiiensis* (Ewing), *Echinolaelaps echidninus* (Berlese), and an unidentified species of the genus *Uropoda*. One species of louse, *Polyplax spinulosa* (Berm.), was taken.

Treatment.—In treating any premise with DDT, it is desirable to apply the dust in such a manner as to insure its contact with the rat ectoparasites. Whenever possible, the DDT dust should be applied directly to the ectoparasite breeding places which are usually associated with rat nests and harborages. Rat fleas, which spend part of their time off their host, are found abundantly in these places. Any place suspected of containing a rat nest or providing harborage, therefore, must be given a thorough dusting. Indirect means of contact, however, will have to be relied upon partly, and in some cases wholly. Dust applied along active rat runways will be picked up on the feet and tails of the rats as they move along the runways, and thereby will be carried back to the nest and harborage areas. Rats also will pick up dust over their entire bodies when passing through dusted holes and burrows, which frequently are no longer than is necessary to allow passage of the rat. In addition, rats habitually preen themselves, and dust accumulated on their feet will be transferred to the fur in this manner. Fleas on the rats then will contact the DDT dust while moving through the fur.

The quantity of dust necessary for any single treatment will vary within wide limits, due to the large variation in the size and character of the places to be treated. In general, the quantity of dust will be proportional to the amount of rat infestation. The 11 test establishments used in this study were treated with an average of 8 pounds of 10-percent DDT dust.

The method of treatment of the test establishments used in this study was as follows. A dust composed of 10-percent DDT in pyrophyllite was applied to rat runways, rat burrows and rat harborages at the average rate of 8 pounds per premise. Particular effort was made to treat burrows and harborage areas thoroughly. On completion of dusting into burrows and holes with the cyanogas foot pump [2] described below, a small amount of dust was placed directly in the mouth of the hole, and if the hole was in a horizontal plane, a ring of dust was laid around it (fig. 3). This procedure was used to insure maximum contact by the rats on entrance. That maximum contact occurred was borne out by the fact that dust so applied usually had been wiped up to a large degree by the passage of rats after several days had elapsed.

Occasionally, it was necessary to remove materials which might become contaminated with DDT, or to move merchandise, rubbish, or other materials to gain access to the more important rat infestations. Such a procedure is recommended, for it has been found that a complete treatment of the rat-infested premise is necessary for the over-all control of rat fleas. In one establishment, a single runway was omitted from dusting operations because of sacked grain tightly stacked throughout its length. Although the rat fleas were almost eliminated from all other parts of the premise, rats trapped along this runway after treatment continued to show considerable numbers of fleas. In another premise, fleas were not eliminated from a single feed room (of a 12-room premise) omitted from treatment.

Equipment.—Many different pieces of dusting equipment were tested for practicability in the DDT dusting work. Two types of equipment were selected on the basis of actual field performance.

[2] The cyanogas foot-pump duster is a product of American Cyanamid & Chemical Corp., New York, N. Y.

(1) Cyanogas foot-pump duster: This duster can be obtained with a 5-pound-capacity cylinder (fig. 1A) which is quite suitable for the work. The 1-pound-capacity jar-type duster (fig. 1B) works just as well but needs frequent refilling. This type of duster was used to blow 10-percent DDT dust into the burrows, holes leading into double floors and walls, and any other enclosed places suspected of being possible nesting or harboring places for rats (fig. 2). Treatment of these nests and harborages with the cyanogas foot duster was the primary aim of each control study reported herein. It is felt that the greater part of both initial and lasting control of *X. cheopis* was achieved through use of this duster.

(2) Hand-shaker dusters: These dusters were designed to accomplish a definite purpose: i. e., to apply a light layer of dust along a rat runway quickly and without billowing. The large type (figs. 4A and 5A) was used to dust runways in which there were no obstructions and in which there was freedom of movement, as shown in figure 6. The smaller hand duster with extension handle (figs. 4B and 5B) was used to dust out-of-the-way rat runs and such places to which access was

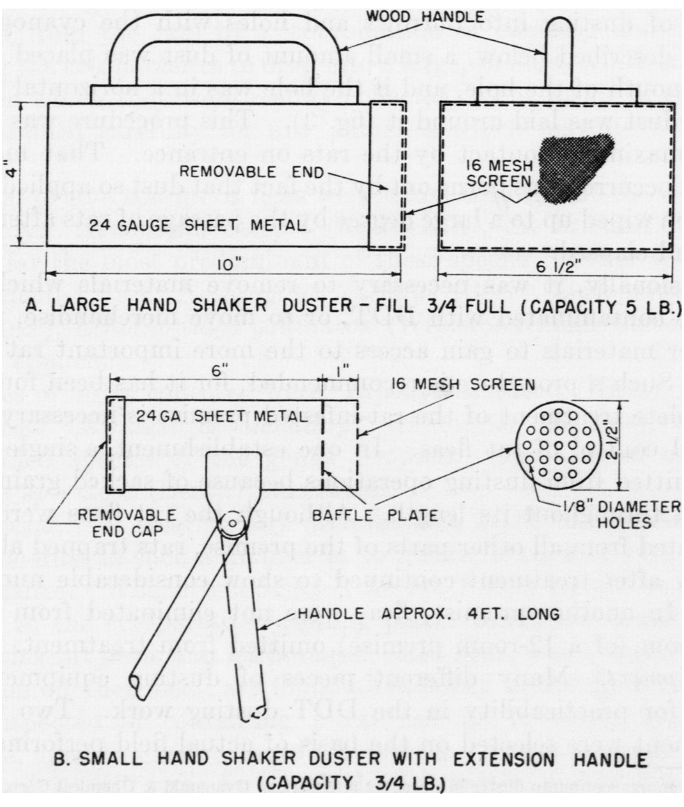

FIGURE 5.

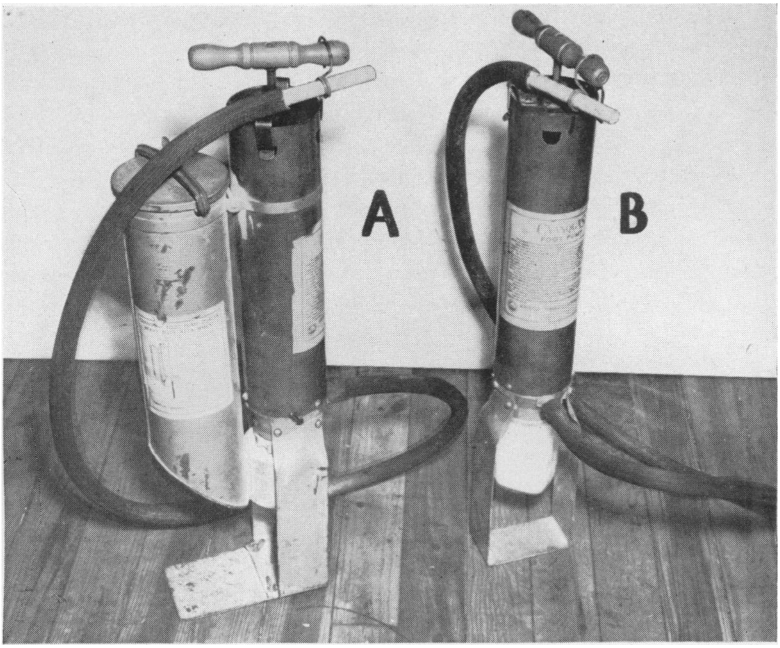

FIGURE 1.—Cyanogas foot-pump dusters used to treat enclosed harborages.

FIGURE 2.—Operating the cyanogas foot-pump duster on a typical rat burrow.

FIGURE 3.—Typical rat burrow showing ring of DDT dust applied after treating with cyanogas foot-pump duster.

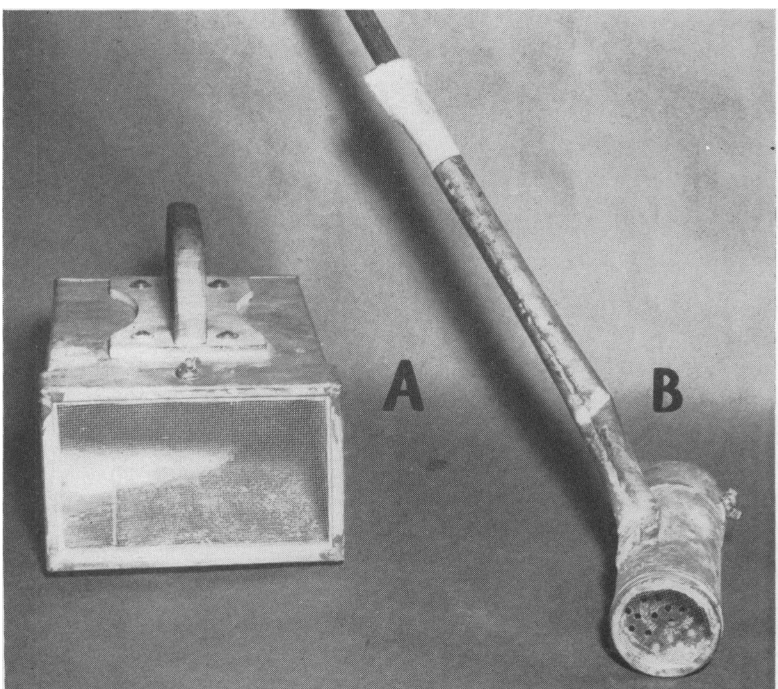

FIGURE 4.—Hand-shaker dusters designed to treat rat runways.

difficult, as shown in figure 7. This duster was also very useful to dust overhead runs, and along beams and wall plates. These hand-shaker dusters also were used to apply a generous layer of dust at the mouths of burrows and at the openings into enclosed places which already had been treated with the cyanogas foot duster.

Precautions.—DDT is a poisonous substance and, although there have been very few recorded cases of human poisoning, the material should be used with some degree of caution. Dusting operators should be especially careful to prevent contamination of foodstuffs. The hand-shaker duster was designed to meet this requirement, since blower-type dusters tend to billow the dust, and controlled application becomes very difficult. Grain sweepings from treated establishments should not be used for food purposes, and the managements should be so informed. The dusting operator also should be protected when exposed to DDT dusts for considerable periods of time. An ordinary dust respirator affords satisfactory protection.

RESULTS

The evaluation of the studies in the 11 establishments treated with 10-percent DDT dust is based primarily on the control of the oriental rat flea, *X. cheopis* (Rothschild). The original objective was to determine the extent and period of control of all of the more important ectoparasite species found on rats, especially those thought to be possible vectors of endemic typhus fever. Of the 10 species of ectoparasites found on rats in Savannah, Ga., only *X. cheopis* was found in sufficient numbers and with a uniformity of distribution throughout the study period (May 1 to November 1, 1945) to permit an analysis of seasonal population variations. (See footnote to table 1.)

The normal populations of *X. cheopis* for the period May through October are shown in figure 8. This curve has been plotted as an average of all data collected in a total of 46 untreated establishments, all very similar to the 11 treated establishments and chosen to be representative of the city as a whole. There were 356 rats used in all, with each point on the curve determined by examining from 31 to 88 rats. The results compare favorably with normal population curves calculated by Cole (*1*) for this species in Savannah, Ga., for the years 1932 and 1933, and also with the *X. cheopis* curve for Jacksonville, Fla., for 1934 as reported by Rumreich and Wynn (*2*). Figure 8 also shows the average number of *X. cheopis* per rat (this arithmetic mean being used as an index to the ectoparasite population throughout this study) for the 11 treated establishments which have been plotted in the proper position with respect to the date scale. Since the 11 studies were not all started at the same time, it was necessary to compute a mean trapping date for each study period. These mean dates are

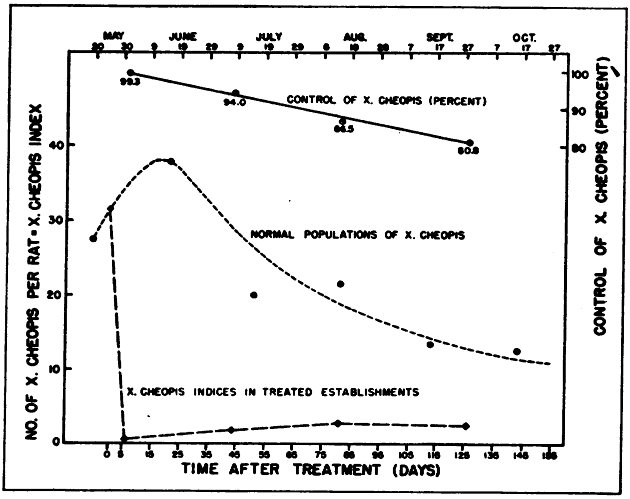

FIGURE 8.—Control of *Xenopsylla cheopis* fleas with 10-percent DDT dust.

listed in table 1. Each plotted index is the average for all of the establishments falling in each study period. The mean treatment date was May 25, as shown in figure 8. Percentage control figures have been computed, using the *X. cheopis* index obtained from treated establishments, and normal *X. cheopis* population as determined by sampling untreated establishments, for each study period.

TABLE 1.—*Results of DDT dusting for rat fleas, May 1 to Nov. 1, 1945*

Number of days after treatment	Mean trapping date	Number of live rats examined	*Xenopsylla cheopis*			Total fleas		
			Number	Index	Percentage control	Number	Index	Percentage control
Pretreatment	May 19	70	1,927	27.5		2,721	38.9	
5–11	May 30	59	12	.2	99.3	14	.3	99.5
28–53	July 8	50	86	1.7	94.0	87	1.7	(1)
68–94	Aug. 14	49	125	2.6	86.5	132	2.7	(1)
98–162	Sept. 28	48	121	2.3	80.8	127	2.6	(1)

[1] Species of fleas encountered other than *Xenopsylla cheopis* (Rothschild) were: *Nosopsyllus fasciatus* (Bosc), *Leptopsylla segnis* (Schönherr), *Echidnophoga gallinacea* (Westwood), and *Ctenocephalides felis* (Bouché). These species made up a very minor proportion of the total population in both treated and untreated establishments between June 15 and November 1, 1945. Their numbers were too few to enable normal population trends to be determined, and consequently the degree of control could not be figured after the 5-11-day post-treatment period. However, on the basis of initial control, at a time when the population was still relatively high, it is thought that subsequent degrees of control would approximate that for *X. cheopis*.

As indicated on the graph (fig. 8), the initial control achieved against *X. cheopis* was 99.3 percent. Control falls off approximately 5 percent each month during the 4 months following dusting. It should be emphasized that the spectacular control of *X. cheopis* (and of other fleas in the initial period) was very consistent in all of the treated establishments (table 2).

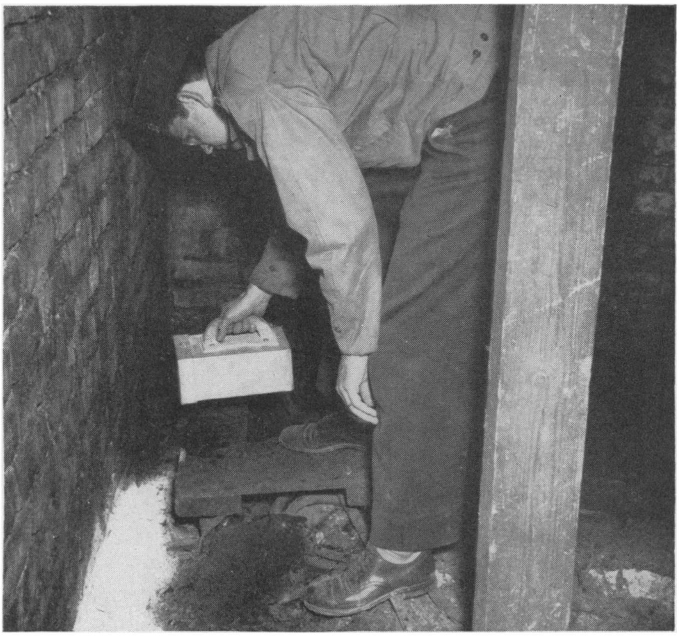

FIGURE 6.—Operation of large hand-shaker duster along typical open rat runway.

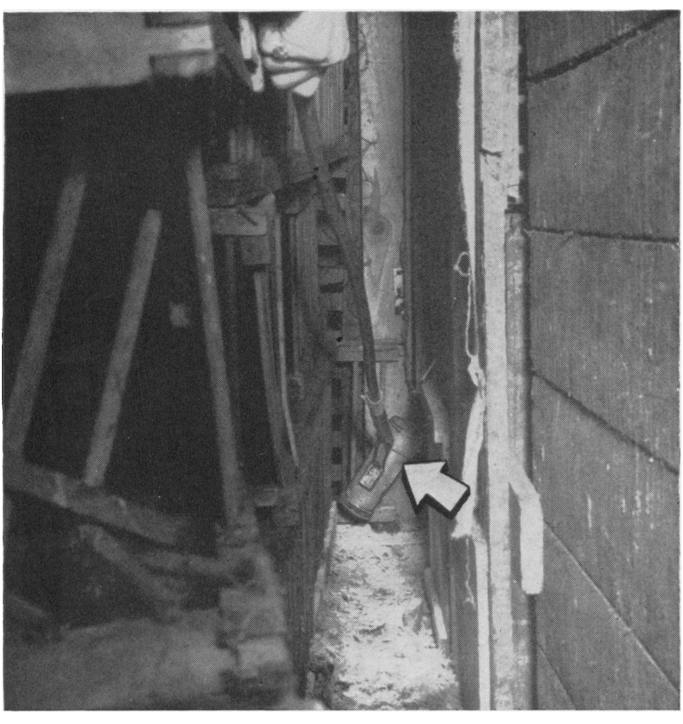

FIGURE 7.—Operation of small hand-shaker duster in an out-of-the-way runway.

TABLE 2.—*Initial results of DDT dusting for rat fleas, May 5 to June 27, 1945*

Type of establishment	Pre- and post-treatment periods	Number of live rats examined	Indices: *Xenopsylla cheopis*	*Nosopsyllus fasciatus*	*Leptopsylla segnis*	*Echidnophaga gallinacea*	*Ctenocephalides felis*	Total fleas
Wholesale grocery	Pretreatment	8	10.0	1.7	16.5	0	0.1	28.4
	5–7 days	4	0	0	0	0	0	0
Poultry hatchery	Pretreatment	2	30.0	0	0	.5	0	30.5
	6–11 days	3	0	0	0	0	0	0
Wholesale grocery	Pretreatment	10	42.6	0	22.1	13.5	1.7	79.9
	7–8 days	8	1.0	0	0.1	0	0	1.1
Do	Pretreatment	5	5.8	1.2	8.4	.2	0	15.6
	6 days	2	.5	.5	0	0	0	1.0
Produce and poultry company	Pretreatment	7	5.1	.1	1.0	0	.1	6.4
	5–9 days	6	0	0	0	0	0	0
Feed and pet store	Pretreatment	5	28.6	.4	0	.2	1.4	30.6
	10 days	1	1.0	0	0	0	0	1.0
Poultry company	Pretreatment	7	40.0	1.0	8.6	14.3	5.0	68.9
	5–6 days	6	0	0	0	0	0	0
Retail grocery	Pretreatment	8	57.5	0	0	0	0	57.5
	5–6 days	10	.1	0	0	0	0	.1
Do	Pretreatment	6	22.7	.2	0	0	0	22.8
	7–9 days	6	.2	0	0	0	0	.2
Restaurant	Pretreatment	8	29.5	0	0	0	.3	29.8
	5 days	7	0	0	0	0	0	0
Retail grocery	Pretreatment	4	10.2	0	0	0	0	10.2
	7–10 days	6	0	0	0	0	0	0
Mean indices	Pretreatment	70	27.5	.4	6.6	3.4	.9	38.9
	5–11 days	59	.2	.01	.01	0	0	.3

TABLE 3.—*Results of DDT dusting on mites and lice infesting rats, May 5 to June 27, 1945*

Type of establishment	Pre- and post-treatment periods	Number of live rats examined [1]	Mite indices: *Liponyssus bacoti*	*Echinolaelaps echidninus*	*Laelaps hawaiiensis*	*Uropoda* species	Total mites	Louse index—*Polyplax, spinulosa*	Total ectoparasite index, including fleas
Wholesale grocery	Pretreatment	8	21.9	0	0	0	21.9	0.1	50.4
	5–7 days	4	45.0	0	0	0	45.0	0	45.0
Poultry hatchery	Pretreatment	2	5.0	0	0	0	5.0	6.0	41.5
	6–11 days	3	0	0	.3	0	.3	0	.3
Wholesale grocery	Pretreatment	10	50.6	0	0	0	50.6	11.4	141.9
	7–8 days	8	17.5	0	0	.3	17.8	.3	19.1
Do	Pretreatment	5	50.0	0	.8	0	50.8	13.4	79.8
	6 days	2	5.0	0	0	0	5.0	0	6.0
Produce and poultry company	Pretreatment	7	0	0	.6	5.3	5.9	24.0	36.3
	5–9 days	6	.2	0	0	.8	1.0	5.2	6.2
Feed and pet store	Pretreatment	5	7.6	0	84.0	.2	91.8	83.2	205.4
	10 days	1	0	0	0	0	0	0	1.0
Poultry company	Pretreatment	7	1.0	0	1.9	0	2.9	10.0	81.7
	5–6 days	6	5.8	0	0	.4	6.2	22.8	29.3
Retail grocery	Pretreatment	8	.1	33.1	.4	.1	33.8	2.8	94.0
	5–6 days	10	.7	1.2	0	0	1.9	.2	2.2
Do	Pretreatment	6	19.0	.5	0	0	19.5	.3	42.7
	7–9 days	6	3.7	0	0	.3	4.0	.2	4.3
Restaurant	Pretreatment	8	14.5	0	5.6	.1	20.3	5.0	55.0
	5 days	7	14.7	0	0	0	14.7	1.1	15.9
Retail grocery	Pretreatment	4	.5	0	.3	.5	1.3	8.2	19.8
	7–10 days	6	0	0	0	.5	.5	5.3	6.2
Mean indices	Pretreatment	70	17.4	3.8	7.0	.6	28.8	13.5	81.2
	5–11 days	59	8.4	.2	.02	.3	8.9	3.6	12.8

[1] All rats here indicated were caught over a total period of 27 days and over a mean period of 11 days.

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Mite and louse populations showed, in both treated and check establishments, a large variation which was of a magnitude too great to make an exact population analysis possible in this study. An initial control of these species, however, is indicated for the 5–11-day period following treatment (table 3). These figures must be considered approximate because of the normally extreme variation which occurs in the number of mites and lice found on individual rats. It does not seem justified to indicate the degree of control attained on the basis of the data at hand.

SUMMARY

Field studies were initiated to determine the degree of control effected against rat ectoparasites by treating rat-infested premises with 10-percent DDT dust. Eleven study premises were trapped before treatment, 1 week following treatment, and at approximately monthly intervals thereafter. From rats trapped in untreated premises, only the oriental rat flea, *X. cheopis*, was found in sufficient numbers and uniformity of distribution to permit an analysis of normal seasonal populations.

Treatment was effected by blowing the 10-percent DDT dust into burrows and enclosed harborages with a cyanogas foot-pump duster and by sifting a light layer of dust along rat runways with hand-shaker dusters.

Spectacular and consistent control of *X. cheopis* resulted in all 11 establishments, with the control percentage dropping off from an initial 99.3 percent at the rate of approximately 5 percent per month for the 4 months following treatment.

A degree of control was achieved against rat mites and rat lice, but data were insufficient to justify the statement of a definite percentage.

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OBSERVATIONS ON THE NIGHTTIME RESTING AND BITING HABITS OF ANOPHELINE MOSQUITOES IN DDT-TREATED AND -UNTREATED BUILDINGS [1]

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Laboratory cage tests and controlled experiments in houses have clearly demonstrated that residual-spray deposits of DDT are lethal to mosquitoes for considerable periods. Although these tests gave

[1] From Communicable Disease Center, Technical Development Division (Savannah, Ga.), States Relations Division.

valuable information on the durability of DDT residual deposits, they did not give information on the mortality of malaria mosquitoes naturally entering treated dwellings in search of a blood meal. In order to secure a lethal dose of DDT from residual deposits, mosquitoes must actually touch the material and be exposed to it for a considerable period. This period has been shown to vary (*1*), depending on the temperature, age of treatment, density and distribution of the DDT crystals, and the resistance of the individual mosquitoes. Thus, the habits of the mosquitoes in question are of prime importance in determining the likelihood of their being exposed to DDT deposits for a sufficient time to produce death. If, after entering a treated house, mosquitoes spend all or most of their time flying around, or if they proceed directly to a host, feed, and leave immediately, it is obvious that they would not secure a lethal exposure to the DDT. While it has been known for some time that *Anopheles quadrimaculatus* mosquitoes spend most of their daytime hours resting quietly in dark, damp, cool, quiet places, no detailed information has been noted on their hour-to-hour activities in buildings during the night or on the length of time they rested on walls or ceilings before or after feeding. It was to gain some idea of these activities that the studies herein described were undertaken.

PROCEDURE

Observations on the nighttime behavior and resting habits of anopheline mosquitoes were conducted in rooms especially prepared for the study. The walls and ceilings of these rooms were marked off by means of chalk lines into rows of squares, each of which had an area of approximately 1 square yard. Each row was designated by a letter and each square by a number, so that they could be easily located. Scale drawings were made of the walls and ceilings, showing the squares and all surfaces upon which a mosquito might rest. These charts were used for plotting the exact location of all mosquitoes observed during the night studies. For rapidity of observation the room was divided into sections, and each observer was furnished with a drawing of the section assigned to him.

The rooms used in the study had one or more windows and doors which were left open so that mosquitoes could enter or leave at will. A cow, goat, or the observers themselves served as attractants for the mosquitoes.

Each night study was divided into observation periods which were spaced at intervals ranging from 15 minutes to over an hour, depending on the number of mosquitoes to be counted and their degree of restlessness. All observation periods were numbered consecutively throughout the night. These numbers were used as subscripts to the symbols representing the mosquitoes, to indicate the periods when the mosquito was first and last seen. At each counting period, the observer used a flashlight to cover systematically the area corresponding to that appearing on the chart. He began at the same spot each time and plotted the location of all resting mosquitoes seen by placing a symbol on the chart at the proper point. A different symbol was used to indicate the type of mosquito seen (whether anopheline or culicine, engorged or unengorged). During each observation period, the locations of all mosquitoes were checked against the symbols on the chart, and if a mosquito corresponded with a point plotted for a preceding period, it was presumed to be the same mosquito. If a mosquito was not indicated by a symbol on the chart, it was judged to have just entered the building, and a new mosquito locus was plotted on the chart, and given a subscript indicating the number of the period. If there was no mosquito for a previously plotted symbol, the number of the period in which it was last seen was used as the second subscript number to indicate the length of the resting period. Thus, an analysis of the data from the charts of all observers on a given night enabled the computation of the average resting period for each type of mosquito noted, as well as the actual number of each type present at various times of the night. Since every mosquito which shifted resting positions during the night accounted for more than one mosquito locus, the total number of mosquito loci plotted throughout the night was always greater than the total number of mosquitoes actually entering the room. To reduce this error to a minimum, care was exercised in the use of the flashlights.

These overnight studies were carried out in two types of buildings, a small cow barn before and after treatment, and a test room 3 and 4 months after treatment.

Two all-night observations were conducted in the small cow barn before treatment, and a third observation was made after spraying. During these observations, a cow was tethered in the building as a bait animal. The pretreatment counts were made on the nights of September 1 and 5, 1944, and the posttreatment count on the night of September 25, 1944. The treatment consisted of 200 mg. of DDT per square foot. Studies in the test room were carried out in late September 1945, 4 months after a treatment at the rate of 117 mg. of DDT per square foot. A crated goat was used as a bait animal, in addition to the three observers who were present during the test. All windows were left open and unscreened, to allow free movement of the mosquitoes into and out of the room. Early in the evening, observations were made at hourly intervals, but these intervals were reduced to 15 minutes when it became apparent that the mosquitoes were all moving at least once during each period.

Five overnight studies were made on the biting habits and knockdown of mosquitoes in this same test room 3 months after spraying. During these studies, the investigator spent the night on a cot without a bed net, so that the mosquitoes which entered could feed on him at will. He noted the number of biting attempts and made gross observations throughout the night as to the number and kind of mosquitoes in the room. During the first three studies, an exit trap was placed in one window, while the other two windows were left open on the first night and provided with inlet cones on the second and third nights. The inlet windows were screened an hour before dawn to prevent the entrance of mosquitoes seeking daytime resting places. In the last two studies, no traps were used and the windows were not screened to prevent the entrance of mosquitoes just before dawn. All mosquitoes were collected from the test room and the exit trap at approximately 9 o'clock the following morning and classified as to species and condition. Precipitin tests were made on all fully engorged females for the determination of blood meals.

Two similar studies were made, with a cow as bait, in a barn which had been sprayed 11 months previously at the rate of 200 mg. of DDT per square foot. Sheets were spread on the floor during the night to catch the moribund mosquitoes. These were gathered up at 5:30 a. m. so as to retain all mosquitoes knocked down during the night, while eliminating those mosquitoes entering in search of a daytime resting place.

RESULTS AND DISCUSSION

The numbers of engorged and unengorged *A. quadrimaculatus* females noted in the cow barn during the two prespraying studies made in September 1944, are shown in table 1. In each of the studies engorged mosquitoes accounted for only about 14 percent of the total number observed, even though a cow was in the barn throughout

TABLE 1.—*Results of nighttime counts of* Anopheles quadrimaculatus *mosquito loci in an untreated barn, with calculated average resting periods for unengorged and engorged females*

Date	Unengorged females			Engorged females		
	Number	Resting period (in minutes)		Number	Resting period (in minutes)	
		Average	Standard deviation		Average	Standard deviation
Sept. 1-2	1,227	184±4	±138	211	180±9	±129
Sept. 5-6	770	140±3	±86	134	155±10	±115
Total	1,997	167±3	±122	345	170±7	±124

the night. Contrary to expectations, the observed resting period of the unengorged and engorged mosquitoes was not significantly different. For the two nights, the observed average resting period for the unengorged mosquitoes was 167 minutes, and for the engorged 170 minutes.

There was considerable variation in the observed resting period of the mosquitoes, some remaining in place for only a few minutes, others remaining in place for over 10 hours. It was evident that some mosquitoes moved due to the disturbing influence of the lights used in counting. Since the actual time that each mosquito rested on a particular spot was always greater than the observed resting period, the averages are somewhat low. Further, the calculation of these averages was complicated by the fact that over a third of the total number, or some 909 mosquitoes, did not move after alighting and were still in place at 7 a. m. and remained in the same position during most of the day. Because it was desired to obtain the average nighttime resting period, it was arbitrarily decided to include only the period up to 7 a. m. in the calculation of the average resting periods.

The posttreatment study was conducted later in September and on a somewhat cooler night, during which the temperature dropped to 62° F. As a result, a much smaller number of mosquitoes entered the barn. The number of mosquitoes observed resting in the barn and their average resting periods are shown in table 2.

TABLE 2.—*Numbers of* Anopheles quadrimaculatus *females resting in a DDT-sprayed barn, with average resting periods*

Date	Unengorged females			Engorged females		
	Number	Resting period (in minutes)		Number	Resting period (in minutes)	
		Average	Standard deviation		Average	Standard deviation
Sept. 24-25	59	40±3	±24	27	33±4	±20

As indicated, the resting period after treatment was greatly shortened, possibly due to the irritating effect of the DDT deposit. Differences in the resting periods before and after treatment and the percentage of the total mosquitoes resting for stated periods are shown graphically in figure 1. Although the average resting period of *A. quadrimaculatus* on an untreated surface is considered adequate for obtaining a lethal dose of DDT under most conditions, it is apparent that the normal resting periods do not prevail after treatment

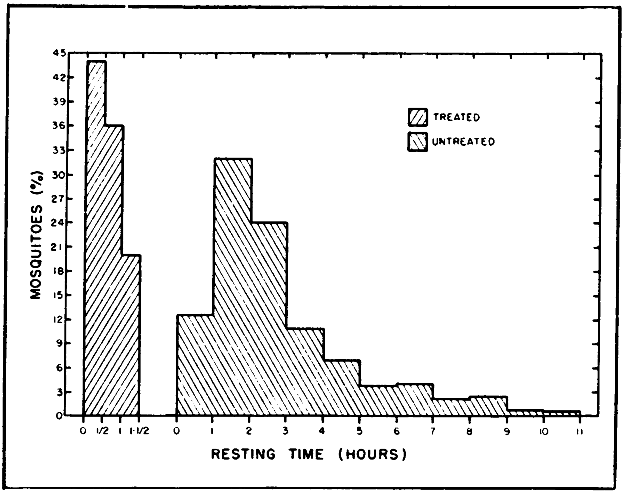

FIGURE 1.—Nighttime resting periods of *Anopheles quadrimaculatus* mosquitoes in a cow barn before and after treatment with 200 mg. of DDT per square foot as indicated by the percentages resting for stated intervals.

and cannot be used in determining exposure to sprayed surfaces. However, it is indicated that, in general, a large percentage of the mosquitoes will rest on treated surfaces for a period sufficient to insure a lethal dose. The fact that before treatment only about 14 percent of the observed *A. quadrimaculatus* females were engorged, even though a cow was continually present in the barn, indicates that many of those naturally entering buildings for the purpose of feeding rest on walls for some time before feeding, as well as after they have fed. In the treated barn about 31 percent of the resting females were engorged. This greater percentage of engorged females in the sprayed barn may indicate that many mosquitoes which entered and rested on the walls temporarily before biting, were so irritated that they left without biting, thus increasing the ratio of fed to unfed individuals. This may be the explanation for the lack of mosquito annoyance experienced by occupants of treated houses immediately after spraying, who often report freedom from bites for the first week or two. Following this there is a period of several weeks during which the annoyance gradually increases, even though a high percentage of the biting mosquitoes are subsequently killed by exposure to sprayed surfaces.

At dusk a considerable number of mosquitoes entered the barn in a few minutes; this occurred both before and after treatment. Before treatment the number of mosquitoes resting in the barn increased progressively throughout the night (fig. 2). The average number of mosquitoes present each hour and the increase in number each hour

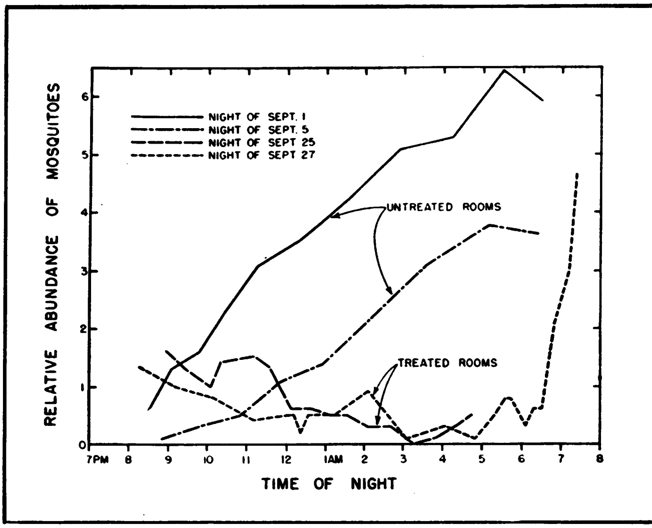

Figure 2.—A comparison of the behavior and trends in abundance of nighttime resting *Anopheles quadrimaculatus* mosquitoes in untreated and treated buildings. Each unit on the vertical scale represents 100 mosquitoes for the untreated rooms and 10 mosquitoes for the treated rooms.

are shown in table 3. The number of unengorged mosquitoes increased throughout the night, with the greatest increase occurring between 1:30 and 2:30 a. m. The engorged mosquitoes decreased steadily after 11:30 p. m.

Table 3.—*Observed numbers of* Anopheles quadrimaculatus *mosquitoes resting in an untreated barn each hour of the night (average of 2 studies), and the increase each hour*

Time	Unengorged females	Increase	Engorged females	Increase	Total females	Total increase
8:30 p. m.	22	22	12	12	34	34
9:30 p. m.	60	38	25	13	85	51
10:30 p. m.	93	33	41	16	134	49
11:30 p. m.	129	36	63	22	192	58
12:30 a. m.	185	56	61	−2	246	54
1:30 a. m.	239	54	58	−3	297	53
2:30 a. m.	307	68	55	−3	362	75
3:30 a. m.	365	56	48	−7	411	49
4:30 a. m.	408	45	44	−4	452	41
5:30 a. m.	465	57	43	−1	508	46
6:30 a. m.	440	−25	46	3	486	−22

After treatment conditions were reversed. Following the rapid influx at dusk (fig. 2), the number of mosquitoes in the barn did not increase, and after midnight decreased. The number counted at each observation period is shown in table 4. Differences in the number of mosquitoes present during each hour of the night before and after treatment are shown graphically in figure 2. The reduction of the number of resting mosquitoes in a treated building, as indicated in figure 2, might well be one reason for the protection afforded by DDT residual sprays.

TABLE 4.—*Numbers of* Anopheles quadrimaculatus *mosquitoes resting in a DDT-treated barn at various times during the night and the increase or decrease between periods*

Time	Unengorged females	Increase	Engorged females	Increase	Total females	Total increase
9 p. m.	14	14	2	2	16	16
9:30 p. m.	11	−3	2	0	13	−3
10 p. m.	6	−8	4	2	10	−3
10:30 p. m.	10	2	4	0	14	1
11 p. m.	12	2	3	−1	15	1
11:30 p. m.	11	−1	2	−1	13	−2
12 m	3	−8	3	1	6	−7
12:30 a. m.	3	0	3	0	6	0
1 a. m.	3	0	2	−1	5	−1
1:30 a. m.	3	0	2	0	5	0
2 a. m.	2	−1	1	−1	3	−2
2:30 a. m.	2	0	1	0	3	0
3:15 a. m.	0	−2	0	−1	0	−3
3:45 a. m.	1	1	0	0	1	1
4:15 a. m.	2	1	1	1	3	2
4:45 a. m.	2	0	3	2	5	2

Observations in a treated room indicated much the same conditions as those observed in the barn after treatment. Following the rapid influx of mosquitoes at dusk, the mosquitoes rested only a short period and left. This condition existed until about 6:30 a. m., when there was an influx of mosquitoes in search of daytime resting places (fig. 2). The number of mosquitoes observed at each counting period is shown in table 5.

TABLE 5.—*Observed numbers of* Anopheles quadrimaculatus *mosquitoes resting in a DDT-treated room at various times during the night*

Time	*Anopheles quadrimaculatus* females			Culicines
	Unengorged	Engorged	Total	Total
8:20 p. m.	13	0	13	22
9:05 p. m.	10	0	10	15
10:05 p. m.	7	1	8	0
11:05 p. m.	3	1	4	1
12:10 a. m.	4	1	5	1
12:20 a. m.	2	0	2	1
12:35 a. m.	5	0	5	2
12:50 a. m.	5	0	5	2
1:15 a. m.	5	0	5	4
2:05 a. m.	8	1	9	3
3:05 a. m.	1	0	1	1
4:05 a. m.	3	0	3	4
4:50 a. m.	1	0	1	0
5:20 a. m.	3	2	5	6
5:35 a. m.	7	1	8	3
5:50 a. m.	8	0	8	2
6:05 a. m.	3	0	3	2
6:20 a. m.	6	0	6	0
6:35 a. m.	6	0	6	2
6:50 a. m.	17	4	21	3
7:05 a. m.	17	18	30	5
7:20 a. m.	24	23	47	3

These results also indicate that in treated buildings the mosquitoes quickly become irritated, so that their resting period is reduced to a matter of minutes. Since no anopheline mosquitoes and only one of the culicines remained beyond the 15-minute intervals, it is assumed that the maximum resting period is less than 15 minutes. Engorged mosquitoes comprised 23 percent of the observed mosquitoes.

The results of the five overnight biting and knock-down studies which were conducted in the test room 4 months after treatment at the rate of 117 mg. of DDT per square foot are summarized in table 6. In the first three studies the entrance windows were screened an

TABLE 6.—*Numbers of naturally entering mosquitoes, active and knocked-down, recovered from a test room which had been sprayed 4 months previously with DDT, and the source of their blood meals as indicated by precipitin tests*

Group	*Anopheles quadrimaculatus*			Culicines		
	Engorged	Unengorged		Engorged	Unengorged	
	Females	Females	Males	Females	Females	Males
GROUP 1						
(3 studies)						
(Windows closed before dawn)						
Down on floor	5 H,[1] 1 U	41 A. cr. 2	1	1 H, 4 N	129	
Alive in room					1	
Down in traps	3 N, 2 U	15			14	
Alive in traps	1 H, 1 N	10			3	
GROUP 2						
(2 studies)						
(Windows not closed)						
Down on floor	1 H, 7 E, 30 B, 7 N, 9 U	*56	1	3 H, 1 N, 1 U	11	1
Alive in room	4 H, 2 E, 35 B, 6 N, 6 U	*45			2	1

[1] Supplementary key:
H =Human.
U =Unsatisfactory for test.
N =No reaction.
A. cr.=*Anopheles crucians.*
E =Equine.
B =Bovine.
* =Many were partly engorged.

hour before dawn to shut out those mosquitoes in search of daytime resting places. When this was done, no live *A. quadrimaculatus* mosquitoes and only one live culicine mosquito were found in the room at the 9 a. m. inspection. A total of 34 dead and 15 live mosquitoes were taken in the exit trap. The live mosquitoes were killed for the determination of their blood meals. A total of 18 engorged females, only one of which was alive at the time of inspection, was recovered from the three studies. Of these only six gave positive blood reactions and all of these were for human blood, presumably that of the observer. A total of 215 unengorged mosquitoes was taken. Thus, the engorged mosquitoes comprised only about 7 percent of the total taken. These results indicate considerable protection against biting.

In the last two studies all windows were entirely open and no attempt was made to keep out the predawn flight of *A. quadrimaculatus*. At the 9 a. m. inspection only about half of the mosquitoes had been knocked down, which would seem to indicate that many mosquitoes had entered in search of daytime resting places and sufficient time had not yet elapsed for them to be knocked down. (The KD_{50} for daytime releases of mosquitoes in the room was 120 minutes at that time.) Of the total active and morbid *A. quadrimaculatus* mosquitoes recovered from the room, 41 percent were engorged sufficiently to permit precipitin tests, which showed a number of blood sources, as indicated in table 6. Since bovine blood predominated, it is evident that many entered to rest rather than to feed. However, four of those which were still alive had fed on human blood, whereas only one which was down on the floor had fed on human blood. Over half of the recovered anopheline mosquitoes were engorged, and approximately 10 percent of these had fed on human blood.

In every test the operator reported several times more bites than the number of mosquitoes fully engorged with human blood which were recovered. This was due in part to the escape of the engorged mosquitoes, as indicated by the numbers taken in the exit traps when these traps were in place, and perhaps to several attacks by the same mosquito in becoming fully engorged.

The results of the two overnight biting and knock-down studies in a cow barn sprayed 11 months previously are summarized in table 7.

TABLE 7.—*Number of mosquitoes knocked down in a small barn sprayed 11 months previously with 200 mg. DDT per square foot with the source of blood meals indicated (totals from 2 nights' studies)*

Species	Engorged females	Unengorged females	Males
A. quadrimaculatus	110 bovine, 13 negative, 2 unsatisfactory	10	1
Culicines	24 bovine, 1 avian, 14 negative, 14 unsatisfactory	21	1

These results show that over 11 months after treatment a considerable number of mosquitoes are knocked down before they are able to leave. As all the engorged mosquitoes satisfactory for precipitin tests had been feeding on the cow, it is probable that they had fed in the barn. Among the mosquitoes which had been knocked down and recovered from the barn floor, the engorged ones outnumbered the unengorged by about 2½ to 1.

SUMMARY

Anopheles quadrimaculatus mosquitoes which enter buildings to feed rest on walls or ceilings for considerable periods before as well as after feeding.

The observed nighttime resting period of unengorged and engorged *A. quadrimaculatus* females in an untreated building was not significantly different. The resting period varied greatly, ranging from a few minutes to over 11 hours.

In treated buildings the observed resting period was much shorter than that for untreated buildings, and the range was much less, varying from a few to 90 minutes. The average observed resting period for unengorged and engorged *A. quadrimaculatus* females was not significantly different, being 40 ± 3 minutes for the former and 33 ± 4 minutes for the latter.

After treatment, the percentage of engorged females resting on the walls increased from 14 to 31 percent, perhaps indicating that many of the unengorged mosquitoes are irritated by the DDT and leave before they attempt to bite. Immediately after spraying, irritation is produced in such a short time that considerable protection against biting is afforded.

In the untreated building, the number of *A. quadrimaculatus* females increased throughout the night, reaching a maximum about an hour before daylight, whereas after treatment, the largest number was present just after the influx at dusk, and only a small number of mosquitoes were present at any time during the remainder of the night.

ACKNOWLEDGMENT

This study was carried on with the active assistance of several members of the staff of the Carter Memorial Laboratory. Special thanks are due Senior Assistant Engineer (R) Earl H. Arnold, Senior Assistant Engineer (R) Harry Stierli and Senior Assistant Sanitarian (R) Richard W. Fay for assistance in making the night studies. Sanitarian (R) S. W. Simmons made the project possible and gave valuable advice and assistance in the work. Engineering Aide Fred Freeman gave active assistance in several phases of the work. We are indebted to Junior Assistant Sanitarian (R) Dorothy Fawcett for the determination of the blood meals of the mosquitoes.

REFERENCE

(*1*) Tarzwell, C. M., and Stierli, H.: The evaluation of DDT residual sprays for the control of anopheline mosquitoes in dwellings. Pub. Health Rep. Supplement No. 186, pp. 35–48 (1945).

COMPARATIVE STUDIES OF DDT DUSTS, DDT-OIL SPRAYS, AND PARIS-GREEN DUSTS USED ROUTINELY IN ANOPHELINE LARVAE CONTROL[1]

By WILLIS V. MATHIS, *Assistant Sanitarian (R)*, FREDERICK F. FERGUSON, *Senior Assistant Sanitarian (R)*, and S. W. SIMMONS, *Sanitarian (R)*, *United States Public Health Service*

This paper presents an evaluation of the effectiveness of DDT larvicides in a general malaria-control program.[2] The use of DDT as a dust and as a spray, has been compared to that of paris-green dust. The Savannah, Ga., Malaria Control Area was selected for a large-scale test of the use of DDT as a means of controlling anopheline mosquitoes. This area consists of 41 square miles in which 255 acres and 388,400 feet of small ditches were treated with various larvicides from March 1 to October 19, 1945. The area was divided into three regions of similar breeding characteristics from the standpoint of ease and cost of larviciding. One of the above types of larvicides was used in each region for an entire anopheline-mosquito-breeding season. During the early part of the 1945 season, a DDT-oil-water emulsion applied at 15 gallons of total emulsion per acre was used as a spray; later a DDT-oil mist was applied at the rate of 1 gallon per acre. The DDT and paris-green dusts were dispersed at the rate of 10 pounds of finished dust per acre. In all types of applications an attempt was made to disperse 0.1 pound DDT or 1 pound paris green per acre. Regular larviciding procedures of Malaria Control in War Areas were followed during the study, employing labor-grade personnel. Preliminary training was necessary in the techniques of handling the modified equipment.[3]

Pretreatment larval surveys were made of the stations under control. Posttreatment surveys were made 24 hours and 1 week after treatment. Only stations having an adequate larval population were used in the study. In this work, no attempt was made to determine the effects of DDT on wildlife, other than by very general observations. These observations indicated that considerable numbers of the surface insects were killed by DDT-in-oil mists. No harmful effects were noted by the use of DDT dust.[4]

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[1] From Communicable Disease Center, Technical Development Division (Savannah, Ga.), States Relations Division.

[2] The Georgia State Health Department has cooperated in these tests involving the use of DDT in controlling anopheline mosquito larvae. The authors express their thanks to Mr. L. G. Lenert, Director, State Malaria Control, William Legwen, Sanitary Engineer (R), Assistant Director, and H. F. Johnson, Assistant Engineer (R), Area Supervisor, Savannah, Ga., for their cooperation in this study.

[3] See the discussion of the equipment and techniques involved in Ferguson, F. F., et al.: Control of anopheline mosquito larvae by use of DDT-oil mists (to be published in Public Health Reports).

[4] See the discussion in Tarzwell, C. M., et al.: Effects of DDT mosquito larviciding on wildlife (to be published in Public Health Reports).

DDT DUSTS

The first formula used as a larvicide was 1-percent DDT in a kaolin-type clay. Approximately 10 pounds of finished dust (i. e., 0.1 pound of DDT) per acre was applied with a rotary hand duster. During the time this formula was used, the larval populations were sampled without any distinction as to the instars. From the results obtained in 10 treatments, using only those counts in which the pretreatment populations averaged 0.25 or more larvae per dip, an average reduction of 99 percent was noted 24 hours after treatment. No residual toxicity was detected in the five stations on which a weekly count was taken, each of these stations showing reinfestation when the weekly counts were made. The average sample after 1 week was 43 percent of the original count. As the season progressed, pyrophyllite was substituted for the kaolin as the diluent and the larval counts were recorded by separate instars. Table 1 gives the results of these tests.

TABLE 1.—*Summary of results of counts, by instars, before and following treatment with 1-percent DDT in pyrophyllite, applied at the rate of 10 pounds finished dust per acre*

Instars	Pretreatment count		24 hours after treatment		Percentage reduction at 24 hours	1 week after treatment		Percentage of original pretreatment sample
	Dips	Larvae/dip	Dips	Larvae/dip		Dips	Larvae/dip	
First	1,524	0.925	1,604	0.126	86	1,240	0.792	86
Second	1,524	.457	1,604	.110	76	1,240	.416	91
Third	1,524	.109	1,604	.010	91	1,240	.056	51
Fourth	1,524	.060	1,604	.006	90	1,240	.034	57
Total	1,524	1.551	1,604	.252	84	1,240	1.298	84

Reduction of the second instar was less than that of any other, but it is doubtful that this was due to higher resistance, rather than to errors in instar determinations in the field. In the individual treatments, a few larval populations evidenced very little reduction, and some showed an increase over the original number of larvae found. The cause of these poor population reductions is conjectural. However, it occurred during a period of rainy weather and in some of these tests, rain fell almost immediately after treatment. Other treatments under similar circumstances showed excellent reductions. In order to eliminate possible errors in distinguishing the four instars, the larvae were analytically divided into small (first and second) and large (third and fourth) instars. This produced an average reduction of 83 percent of the small, and 91 percent of the large larvae at the 24-hour post-treatment sampling. As in the first series of tests made with DDT dust, no indication of any residual toxicity was noticed, as the weekly sampling indicated that the small larvae had increased to 76 percent and the large larvae to 59 percent of the original sample. There was some evidence that the treatments with the kaolin diluent for the DDT were more effective than with those using the pyrophyllite diluent. However, both seemed to give satisfactory control.

PARIS-GREEN DUST

A dust consisting of 10-percent paris green in lime applied at the rate of 1 pound of paris green per acre, was used throughout the season on the stations designated for this treatment. The same total amount of dust (10 pounds finished dust per acre) and the same type of rotary hand duster was used in these treatments as was used with DDT dust. During the first period, 19 applications were made and the larval counts were made without any distinction as to respective instars. The results indicate that 24 hours after treatment, a 64-percent reduction of the larvae had been obtained as compared with a 99-percent reduction due to DDT-kaolin. This does not necessarily mean unsatisfactory control of large larvae, for in many counts considerable numbers of the remaining larvae were small. It is usually held that under field conditions, paris-green dust does not give as high a kill of small larvae as it does of the large ones. This is presumably based on the inability of small larvae to ingest paris-green particles. Table 2 contains the results, by instars, obtained with 26 additional applications during the period that the DDT-pyrophyllite dust was used.

TABLE 2.—*Summary of counts, by instars, before and following treatment with 10-percent paris green in lime, applied at the rate of 10 pounds of finished dust per acre*

Instars	Pretreatment count		24 hours after treatment		Percentage reduction at 24 hours	1 week after treatment		Percentage of original pretreatment sample
	Dips	Larvae/dip	Dips	Larvae/dip		Dips	Larvae/dip	
First	1,468	1.106	1,519	0.327	70	1,171	0.877	79
Second	1,468	.291	1,519	.086	70	1,171	.232	80
Third	1,468	.092	1,519	.005	95	1,171	.046	50
Fourth	1,468	.048	1,519	.006	87	1,171	.015	31
Total	1,468	1.537	1,519	.424	72	1,171	1.170	76

In a majority of these tests, a satisfactory reduction of the large larvae was noted. No difference was found between the reduction of the first and the second instars. Some error may be indicated in the distinction between third and fourth instars which may account for the difference in percentage reduction in these instars. The samples taken 1 week after treatment show the degree of reinfestation, in comparison to the original samples, after 1 week. These tests were made over approximately the same period as were the tests on DDT-pyrophyllite dust, and show an over-all reduction of 72 percent at 24 hours as compared with 84 percent for the DDT-pyrophyllite.

DDT IN OIL

The initial DDT-in-oil treatments were made with a quick-breaking emulsion. The oil phase was 1.25 percent DDT, 0.5 percent B–1956,[5] and 98.25 percent No. 2 fuel oil. One gallon of this concentrate was added to 14 gallons of water and applied at the rate of 15 gallons of finished emulsion per acre by the use of a knapsack sprayer, fitted with No. 4 or No. 5 orifice plates. As in the tests on other larvicides, the early-season larval counts were made without any distinction as to separate instars. In 10 such tests, an average reduction in larvae of 95 percent was noted 24 hours after the treatment was made. The weekly sampling indicated that the numbers of larvae had increased to 34 percent of the original number. The method of recording the larval counts was changed at the same time as in the other larvicides; also a new formula and method of application was instituted. This formula was 1.25 percent DDT and 0.5 percent B–1956 in No. 2 fuel oil and was applied at the rate of 1 gallon per acre without the addition of water. The pressure sprayer used was of the open-head type, with a capacity of 1½ gallons. The sprayers were initially charged with 1 gallon of material and during operation the pressure range was maintained at from 30 to 50 pounds per square inch. The sprayer was fitted with an atomizing nozzle[6] which gave a very fine mist spray, using the wind for further dispersion. A swath of approximately 20 to 30 feet was effectively covered at one time. Table 3 gives the results obtained in 12 applications using the oil-mist technique.

TABLE 3.—*Summary of results of counts, by instars, before and following treatment with DDT in fuel oil, applied at the total rate of 1 gallon per acre*

Instars	Pretreatment count		24 hours after treatment		Percentage reduction at 24 hours	1 week after treatment		Percentage of original pretreatment sample
	Dips	Larvae/dip	Dips	Larvae/dip		Dips	Larvae/dip	
First	771	0.873	806	0.017	98	520	0.190	22
Second	771	.454	806	.006	99	520	.083	18
Third	771	.121	806	.002	98	520	.008	7
Fourth	771	.115	806	.004	97	520	.006	5
Total	771	1.563	806	.029	98	520	.287	18

[5] An emulsifier-spreader, a product of the Rohm and Haas Co., Philadelphia, Pa.
[6] Marley 1H41 nozzle, a product of the Marley Co., Kansas City, Kans.

In these tests, a highly uniform reduction of all larval instars was obtained in all plots except one.

The larval counts made 1 week after treatment varied considerably. The number of small larvae (first and second instars) was only 18 percent, whereas the number of large (third and fourth instars) was 6 percent of the original number. It is doubtful if this reflects any residual toxicity from the treatments, for in a majority of the tests at the 1-week check, second-instar larvae were common and a few third and fourth instars were also found. In two tests, the total number of larvae found 1 week after treatment was almost as large as the original sample. The large larvae were found in areas which apparently had a 100-percent reduction of larvae after treatment. Therefore, the reinfestation would have had to ensue very soon after treatment. It is thought that the small number of larvae found 1 week after treatment was the result of the extremely high initial kill. Some stations were treated at weekly intervals throughout the season and larvae were still being found at the end of the season, after the treatments had been discontinued. As is shown in table 3, DDT-in-oil mist is apparently equally effective against each instar. There is no significant difference in the results obtained by the use of the emulsion formula (95-percent reduction at 24 hours and 34-percent reinfestation at 1 week) as compared to the oil-mist formula (98-percent reduction at 24 hours and 18-percent reinfestation at 1 week).

Table 4 is a summary of initial reduction in larval-instar populations and subsequent reinfestation 1 week after each type of treatment.

TABLE 4.—*Comparison of larval reduction 24 hours after treatment and reinfestation 1 week after treatment for DDT dust, paris green, and DDT-in-oil mist*

Instars	10-percent paris-green dust		1-percent DDT-pyrophyllite dust		1.25-percent DDT in fuel oil	
	Percentage reduction at 24 hours	Reinfestation at 1 week	Percentage reduction at 24 hours	Reinfestation at 1 week	Percentage reduction at 24 hours	Reinfestation at 1 week
First	70	79	86	86	98	22
Second	70	80	76	91	99	18
Third	95	50	91	51	98	7
Fourth	87	31	90	57	97	5
Total	72	76	84	84	98	18

POSSIBLE RELATION OF LARVICIDING TO ADULT MOSQUITO POPULATIONS

On the Malaria Control in War Areas (M. C. W. A.) program, *Anopheles* control measures are considered satisfactory when the adult *A. quadrimaculatus* counts in all "A" stations [7] are maintained

[7] "A" stations are natural resting places located within one-quarter of a mile of regions under protection.

below 10 per station. By applying this criterion to the data obtained by the personnel of the Savannah control unit, satisfactory control was obtained in all regions. Only one "A" station showed 10 adults and this occurred only once. It is very difficult to compare the effectiveness of larvicides in different regions by comparing the adult counts; therefore, no attempt was made to get detailed information.

OPERATIONAL ASPECTS

The semimonthly progress reports of the Savannah Malaria Control Unit for 1945 were used as a source of comparative data on the different types of larvicides. The principal interest in these records was the dosage applied and the number of man-hours required to treat a unit area with the different larvicides. Table 5 gives the average dosage and man-hours for the two divisions into which M. C. W. A. divides the larval stations.

TABLE 5.—*Comparison of larviciding operations in terms of dosage of active ingredients and man-hours involved*

Larvicide	Ditches 10 feet or less in width		Ditches and ponds greater than 10 feet in width	
	M. H./100 linear feet	Pounds/100 linear feet	M. H./acre	Pounds/acre
DDT-oil emulsion	0.13	0.0016	4.10	0.05
DDT-oil mists	.06	.0038	1.70	.13
DDT dust	.10	.0056	3.74	.24
Paris-green dust	.09	.04	3.10	1.71

(All figures based on records from Mar. 1 to Oct. 19, 1945.)

In breeding areas 10 feet or less in width, it was found that the DDT-oil-mist formula required less time to treat a unit area than any other method used. Paris-green and DDT dusts required essentially the same time. The DDT-oil-water emulsion required the longest treatment time per unit area whereas the dosage rate, as compared to the other DDT treatments, was only from 30 to 40 percent as great. By computing the number of man-hours required to treat all stations with the 1-gallon-per-acre oil formula and comparing with similar computations for the dusts, it was found that a 36-percent saving in time would have been obtained by using oil.

In breeding areas greater than 10 feet in width, the same trend was followed, both as to the number of man-hours required to treat a unit area and also as to the dosage applied. Again, computations were made to determine the number of man-hours that would have been required to treat all stations either with the 1-gallon-per-acre oil formula or with the dusts, and it was found that a 52-percent saving in man-hours would have been effected if the DDT-oil mists had been used throughout.

The control unit's man-hour total from January 1 to October 19, 1945 was 31,480. Of this number, only 1,966 man-hours were spent in actual larviciding operations, which represents only 6.25 percent of the total man-hours. One station was treated that had an area of approximately 3½ acres. Here, the average man-hours per acre for 11 treatments with the 1-gallon-per-acre oil formula was 1.3 while the average dosage was 0.106 pound DDT per acre. A total of 45 treatments were made on other stations, which ranged from 600 to 63,000 square feet in area. The average number of man-hours per acre for these was 2.66 and the dosage 0.197 (ranging from 0.05 to 0.4) pound of DDT per acre. This indicates that the greatest saving is obtained in the larger plots to be treated.

The cost of materials varied during the season, but late prices were as follows: technical DDT, $0.45 a pound; Neocid, a 10-percent DDT concentrate, $0.31 a pound; paris green, $0.20 a pound; No. 2 fuel oil, $0.08 a gallon; lime and pyrophyllite, $10 per ton; B-1956, $3.80 a gallon. If these prices are used and the treatments are made at the recommended dosage, the cost per acre should be:

0.1 pound DDT in 1 gallon No. 2 fuel oil	$0.15
0.1 pound DDT in pyrophyllite	.36
1 pound paris green in lime	.25

This indicates that the 1-gallon-per-acre oil formula with DDT is approximately 40 percent cheaper than the cheapest dust used.

The regions treated with the various larvicides were given the same care as regards to clearing and cleaning, and therefore should not show any difference in cost for maintenance. However, under recommended control practices, it is anticipated that very little clearing of aquatic or emergent vegetation will be necessary, due to the ability of DDT-oil mists to penetrate plant growth.

When the described work was initiated, insufficient data were available to indicate the lowest practical effective dosage of DDT applicable to routine larviciding. Nor were there sufficient data on the effects of such treatments on wildlife. At that time, the data available indicated that a dosage of 0.1 pound of DDT per acre was acceptable. Parallel tests were conducted on the effects of DDT on wildlife, and the results of this work showed that routine larviciding with DDT in oil at the rate of 0.1 pound per acre caused considerable damage to fish life. Although the present paper is based on the use of 0.1 pound per acre, it has been found that this dosage can be safely reduced by one-half. Dosages of 0.05 pound of DDT per acre give a larval control comparable to the 0.1 pound previously used. At this dosage, it is not indicated that appreciable damage will result to wildlife from normal larviciding operations.

SUMMARY

These data show DDT to be a satisfactory routine anopheline larvicide used as a dust or in an oil-water emulsion at 15 gallons per acre, or when dispersed in a solution at the rate of 1 gallon per acre as an air-borne mist.

High initial toxicity to larvae is ordinarily obtained at an average rate of 0.1 pound DDT per acre whether in a dust, an oil-water emulsion, or in oil solution.

When compared to a 10-percent paris-green dust, a 1-percent DDT dust (both used at a rate of 10 pounds per acre) gives approximately the same control on large larvae and a slightly higher rate of reduction on small larvae.

Either the DDT-oil-water emulsion or the DDT-oil mist gives a higher degree of control of all instars considered separately than does either the paris-green or DDT dust.

Data from control-operation records show that approximately the same time is required to treat breeding areas of 10 feet or less in width, regardless of whether paris-green or DDT dust is used. The 1-gallon-per-acre DDT-oil formula gives a saving of 36 percent as compared with the DDT dust. Use of the DDT-oil-water emulsion requires more time than any other formula used. In breeding areas greater than 10 feet in width, a 52-percent saving was obtained over the paris-green or DDT dust by the use of the 1-gallon-per-acre DDT-oil-mist treatment.

DDT-oil mists used at the rate of 1 gallon per acre are more economical than DDT-oil-water emulsions used at 15 gallons per acre. However, they give essentially the same degree of larval control.

DDT may be successfully handled and applied by labor-grade personnel. Air-borne mechanically atomized mists containing DDT and dispersed from light-weight air-pressure sprayers are shown to be an improvement in larviciding technique.

REFERENCES

(*1*) Arnold, E. H.; Ferguson, F. F.; and Upholt, W. M.: The experimental use of DDT sprays as mosquito larvicides. Pub. Health Rep., Supplement No. 186, pp. 66–80 (1945).

(*2*) Simmons, S. W., and staff: Tests of the effectiveness of DDT in anopheline control. Pub. Health Rep., **60:** 917–927 (Aug. 10, 1945).

DEATHS DURING WEEK ENDED DECEMBER 21, 1946

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

	Week ended Dec. 21, 1946	Corresponding week, 1945
Data for 93 large cities of the United States:		
Total deaths	9,378	10,458
Average for 3 prior years	10,821	
Total deaths, first 51 weeks of year	460,804	460,330
Deaths under 1 year of age	790	617
Average for 3 prior years	618	
Deaths under 1 year of age, first 51 weeks of year	34,215	30,971
Data from industrial insurance companies:		
Policies in force	67,304,021	67,225,173
Number of death claims	11,637	13,511
Death claims per 1,000 policies in force, annual rate	9.0	10.5
Death claims per 1,000 policies, first 51 weeks of year, annual rate	9.4	10.0

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 DECEMBER 28, 1946

Summary

A total of 103 cases of poliomyelitis was reported for the week, as compared with 137 last week and 50 for the 5-year (1941–45) median. Of 8 States reporting 5 or more cases currently, 5 showed increases, as follows (last week's figures in parentheses): Illinois 10 (7), Wisconsin 11 (3), Florida 9 (0), Mississippi 5 (4), and Washington 6 (3). For the 52 weeks of the year, a total of 25,233 cases has been reported, as compared with 13,734 and 19,272, respectively, for the 52-week periods of 1945 and 1944.

The reported incidence of influenza declined during the week. A total of 2,660 cases was reported, as compared with 3,338 last week, 52,947 for the corresponding week last year, and a 5-year median of 3,466. States reporting more than 100 cases are as follows (last week's figures in parentheses): Texas 1,159 (1,726), Virginia 487 (525), South Carolina 271 (510), Arizona 131 (163). Reported cases to date since July 27 total 32,975, as compared with 362,248 for the corresponding period last year and a 5-year median of 32,764.

Current and cumulative figures since the respective seasonal low dates are below the corresponding medians for diphtheria, infectious encephalitis, measles, meningococcus meningitis, scarlet fever, typhoid and paratyphoid fever, and endemic typhus fever. The total for whooping cough for the period since September is also below the median for that period, although the current figure is slightly above the median for the corresponding week. A total of 1,177 cases of tularemia has been reported during the 52 weeks of the year ended December 28, as compared with 818 the preceding year, and 5,337 cases of undulant fever have been reported as compared with 4,804 last year.

Deaths recorded in 93 large cities of the United States for the week totaled 9,380, as compared with 9,378 last week, 11,399 and 9,934, respectively, for the corresponding weeks of 1945 and 1944, and a 3-year (1943-45) average of 11,920. The total for the 52 weeks of the year is 470,184, as compared with 471,729 for the corresponding 52 weeks last year.

Telegraphic morbidity reports from State health officers for the week ended Dec. 28, 1946, and comparison with corresponding week of 1945 and 5-year median

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

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended—		Median 1941–45	Week ended—		Median 1941–45	Week ended—		Median 1941–45	Week ended—		Median 1941–45
	Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945	
NEW ENGLAND												
Maine	1	2	0	2	3	------	123	------	23	0	0	0
New Hampshire	0	0	0	1	2	------	5	1	1	0	0	0
Vermont	1	1	0	------	44	7	168	------	4	0	0	0
Massachusetts	20	3	4	------	------	------	197	157	157	1	3	6
Rhode Island	0	1	1	------	8	8	43	------	3	0	0	0
Connecticut	1	4	0	3	13	11	88	11	20	0	2	2
MIDDLE ATLANTIC												
New York	19	7	11	[1] 5	[1] 71	[1] 15	211	499	499	6	13	19
New Jersey	5	3	3	3	163	21	55	26	38	2	10	10
Pennsylvania	15	8	14	6	22	6	513	354	516	6	10	10
EAST NORTH CENTRAL												
Ohio	10	44	7	8	123	14	167	14	42	4	8	7
Indiana	16	9	9	3	469	37	15	10	25	1	3	4
Illinois	10	7	8	3	56	24	9	303	84	2	14	14
Michigan [2]	7	19	11	1	5	5	30	174	99	1	5	5
Wisconsin	1	4	3	15	1,034	45	57	44	172	1	0	2
WEST NORTH CENTRAL												
Minnesota	4	4	4	------	2	1	6	3	71	0	1	1
Iowa	6	2	2	------	388	1	4	8	33	0	3	2
Missouri	6	5	5	1	52	7	4	55	18	1	4	6
North Dakota	2	0	2	16	679	17	1	------	3	0	0	0
South Dakota	0	2	2	------	2	1	2	3	3	0	1	0
Nebraska	1	0	1	28	144	5	3	5	5	1	0	0
Kansas	3	7	5	17	2,586	10	6	40	40	1	1	1
SOUTH ATLANTIC												
Delaware	0	0	0	------	------	------	1	2	4	0	0	0
Maryland [2]	7	11	9	2	105	5	10	11	11	1	0	2
District of Columbia	1	0	0	1	45	4	29	1	1	0	1	1
Virginia	6	7	10	487	5,907	432	41	29	47	0	2	6
West Virginia	3	15	2	45	2,302	18	63	6	6	1	6	0
North Carolina	4	20	14	------	------	7	48	17	17	1	4	4
South Carolina	1	9	9	271	3,243	674	24	36	36	1	0	1
Georgia	4	8	5	15	497	65	83	14	14	1	6	2
Florida	15	3	5	14	11	11	11	4	4	2	5	1
EAST SOUTH CENTRAL												
Kentucky	2	8	6	------	8,071	25	------	167	32	1	3	3
Tennessee	10	6	6	25	443	61	3	23	66	4	7	5
Alabama	8	12	12	91	1,218	194	13	3	4	1	6	3
Mississippi [2]	22	6	7	------	------	------	------	------	------	1	4	3
WEST SOUTH CENTRAL												
Arkansas	10	8	8	55	1,924	126	4	7	22	0	1	3
Louisiana	1	13	8	43	7,225	10	------	5	5	0	2	2
Oklahoma	8	2	8	85	1,176	120	3	7	7	2	1	1
Texas	19	33	50	1,159	10,660	2,121	42	50	66	4	13	4
MOUNTAIN												
Montana	2	0	1	16	472	15	55	2	41	0	0	1
Idaho	1	2	1	14	1,151	2	3	105	4	0	0	0
Wyoming	1	1	0	27	3	18	4	15	3	0	1	1
Colorado	13	5	5	31	278	69	10	25	32	0	1	1
New Mexico	8	2	1	1	3	1	11	6	------	0	1	1
Arizona	3	3	2	131	1,385	157	39	------	10	0	0	0
Utah [2]	1	0	0	------	369	55	4	27	27	0	2	1
Nevada	0	0	0	------	1	------	------	7	3	0	0	0
PACIFIC												
Washington	1	7	4	------	------	1	6	272	43	1	3	3
Oregon	0	7	4	22	307	18	20	29	55	1	1	2
California	21	21	24	13	285	60	17	146	168	4	14	14
Total	300	341	331	2,660	52,947	3,466	2,251	2,723	4,212	53	162	187
52 weeks	16,193	18,541	15,559	223,172	431,146	421,155	662,972	128,683	602,085	5,631	7,999	7,999
Seasonal low week [3]	(27th) July 5–11			(30th) July 26–Aug. 1			(35th) Aug. 30–Sept. 5			(37th) Sept. 13–19		
Total since low	7,565	11,644	9,072	32,975	362,248	32,764	22,887	26,124	36,455	971	1,504	1,504

[1] New York City only.
[2] Period ended earlier than Saturday.
[3] Dates between which the approximate low week ends. The specific date will vary from year to year.

Telegraphic morbidity reports from State health officers for the week ended Dec. 28, 1946, and comparison with corresponding week of 1945 and 5-year median—Con.

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid and paratyphoid fever [4]		
	Week ended—		Median 1941–45	Week ended		Median 1941–45	Week ended—		Median 1941–45	Week ended—		Median 1941–45
	Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945		Dec. 28, 1946	Dec. 29, 1945	
NEW ENGLAND												
Maine	0	0	0	13	28	22	0	0	0	0	1	1
New Hampshire	0	0	0	4	2	9	0	0	0	0	0	0
Vermont	1	0	0	9	3	6	0	0	0	0	0	0
Massachusetts	3	1	1	144	114	246	0	0	0	2	2	2
Rhode Island	1	0	0	7	5	9	0	0	0	0	0	0
Connecticut	1	1	0	23	28	29	0	0	0	0	0	0
MIDDLE ATLANTIC												
New York	8	3	3	220	233	285	0	0	0	1	2	2
New Jersey	2	1	1	56	56	84	0	0	0	1	2	1
Pennsylvania	1	2	1	90	197	197	0	0	0	0	4	3
EAST NORTH CENTRAL												
Ohio	0	1	1	249	221	225	0	0	0	1	13	5
Indiana	0	1	0	92	54	78	0	1	1	0	1	0
Illinois	10	5	5	101	117	160	0	0	0	4	0	1
Michigan [2]	4	5	1	134	147	160	0	0	0	0	0	2
Wisconsin	11	25	3	73	99	112	0	0	0	0	0	0
WEST NORTH CENTRAL												
Minnesota	3	3	0	35	38	62	0	0	0	0	0	0
Iowa	0	0	0	29	26	50	0	0	0	0	0	0
Missouri	7	3	1	34	41	57	0	1	0	1	1	0
North Dakota	1	0	0	2	12	11	0	0	0	0	0	0
South Dakota	0	0	0	4	9	22	0	0	0	0	0	0
Nebraska	0	0	0	30	18	24	0	1	0	0	0	0
Kansas	3	1	1	40	47	62	0	0	0	0	1	0
SOUTH ATLANTIC												
Delaware	0	0	0	10	4	4	0	0	0	0	0	0
Maryland [2]	0	0	0	21	23	53	0	0	0	1	0	2
District of Columbia	0	0	0	10	9	26	0	0	0	0	0	1
Virginia	2	0	0	33	68	50	0	0	0	0	2	2
West Virginia	0	0	0	19	24	28	0	0	0	0	0	0
North Carolina	1	0	0	13	20	48	0	0	0	0	1	0
South Carolina	0	2	1	0	14	10	0	0	0	0	1	1
Georgia	0	4	0	6	14	17	0	0	0	0	0	2
Florida	9	2	0	7	10	10	0	0	0	3	2	1
EAST SOUTH CENTRAL												
Kentucky	0	0	1	4	49	49	0	0	0	2	0	1
Tennessee	2	0	0	40	20	21	0	0	0	6	6	1
Alabama	2	3	0	12	8	11	0	0	0	1	5	2
Mississippi [2]	5	0	1	8	6	7	0	1	0	0	0	0
WEST SOUTH CENTRAL												
Arkansas	3	1	0	3	7	8	0	1	1	0	2	2
Louisiana	0	0	0	1	25	11	0	0	0	1	3	3
Oklahoma	1	0	0	9	16	21	1	1	1	2	2	1
Texas	0	2	2	20	74	57	0	0	0	3	7	6
MOUNTAIN												
Montana	0	3	0	3	15	15	0	0	0	0	0	0
Idaho	0	0	0	8	6	17	0	0	0	2	0	0
Wyoming	0	0	0	20	4	4	0	0	0	0	0	0
Colorado	1	1	1	31	47	41	0	0	0	0	0	0
New Mexico	0	0	0	6	11	11	0	0	0	0	3	3
Arizona	0	0	0	11	8	9	0	0	0	0	0	0
Utah [2]	1	1	1	21	15	41	0	0	0	0	0	0
Nevada	0	0	0	0	0	0	0	0	0	0	0	
PACIFIC												
Washington	6	7	1	81	40	42	0	0	0	3	0	0
Oregon	0	2	1	15	30	26	0	0	0	0	0	1
California	14	6	6	72	149	149	0	0	0	2	0	1
Total	103	86	50	1,873	2,211	2,858	1	6	6	36	61	61
52 weeks	*25,233	13,734	12,401	112,981	172,389	140,475	333	349	733	*4,003	4,875	5,546
Seasonal low week [3]	(11th) Mar. 15–21			(32nd) Aug. 9–15			(35th) Aug. 30–Sept. 5			(11th) Mar. 15–21		
Total since low	24,767	13,337	12,099	26,686	38,571	38,571	54	76	117	3,528	4,251	4,961

[2] Period ended earlier than Saturday.
[3] Dates between which the approximate low week ends. The specific date will vary from year to year.
[4] Including paratyphoid fever reported separately, as follows: Massachusetts (salmonella infection (1); New Jersey 1; Florida 1.
*Delayed reports included in cumulative total only: poliomyelitis Arkansas 1 case, Wisconsin 37 cases; typhoid fever Arkansas 1 case.

Telegraphic morbidity reports from State health officers for the week ended Dec. 28, 1946, and comparison with corresponding week of 1945 and 5-year median—Con.

Division and State	Whooping cough			Week ended Dec. 28, 1946							
	Week ended—		Median 1941–45	Dysentery			Encephalitis, infectious	Rocky Mt. spotted fever	Tularemia	Typhus fever, endemic	Undulant fever
	Dec. 28, 1946	Dec. 29, 1945		Amebic	Bacillary	Unspecified					
NEW ENGLAND											
Maine	3	9	19								
New Hampshire	1	7	7								3
Vermont	16	52	34								3
Massachusetts	141	93	94								
Rhode Island	9	17	13		1						
Connecticut	11	17	38								1
MIDDLE ATLANTIC											
New York	158	213	213	9	4		1				7
New Jersey	105	97	97	2							
Pennsylvania	116	86	139	1			1				5
EAST NORTH CENTRAL											
Ohio	49	55	87	1					3		1
Indiana	32	18	15				1		11		5
Illinois	67	51	51	3			1		8		24
Michigan [2]	118	64	70	1							2
Wisconsin	177	36	67								1
WEST NORTH CENTRAL											
Minnesota	2		16	2							
Iowa	10		13								6
Missouri	11	3	13			1			10		
North Dakota			2								
South Dakota	4	6	6								
Nebraska	4	1	2								
Kansas	6	7	28						1		1
SOUTH ATLANTIC											
Delaware	6	1	1								
Maryland [2]	39	7	28						2		3
District of Columbia	4	8	8						2		
Virginia	35	34	34			41			6		
West Virginia	23	5	10								
North Carolina	12	20	62						1	1	
South Carolina	14	44	33								
Georgia	19		2		2				1	5	1
Florida	48	2	6							4	1
EAST SOUTH CENTRAL											
Kentucky	23	11	11						1		
Tennessee	9	24	24			1	2		9	2	1
Alabama	97	5	14							3	
Mississippi [2]										1	2
WEST SOUTH CENTRAL											
Arkansas	11	1	17								4
Louisiana	2								1		1
Oklahoma	9	3	3	3					4		
Texas	130	83	95	8	272	71		1	1	7	5
MOUNTAIN											
Montana	3	1	3								1
Idaho	3	42	1								
Wyoming	10	1	3								
Colorado	7	12	12								
New Mexico	10		2		2	2					
Arizona	14		7			20					1
Utah [2]	1	6	11						1		1
Nevada		5									
PACIFIC											
Washington	7	25	25								
Oregon	5	8	8								
California	66	30	121	3	8		2		1	1	3
Total	1,647	1,210	1,570	33	289	136	8	1	63	24	83
Same week, 1945	1,210			41	266	74	5	0	29	44	34
Average, 1943–45	1,356			36	406	134	9	[5] 0	31	[5] 58	
52 weeks: 1946	100,212			2,427	16,712	6,487	617	572	1,177	3,351	5,337
1945	123,554			1,958	24,700	10,495	620	467	818	5,167	4,804
Average, 1943–45	131,860		[5] 176,415	1,995	22,638	9,085	649	[5] 455	782	[5] 4,533	

[2] Period ended earlier than Saturday.
[5] 5-year median, 1941–45.

Anthrax: New York 1 case.
Leprosy: New York 1 case.

WEEKLY REPORTS FROM CITIES [1]

City reports for week ended Dec. 21, 1946

This table lists the reports from 84 cities of more than 10,000 population distributed throughout the United States, and represents a cross section of the current urban incidence of the diseases included in the table

Division, State, and city	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
NEW ENGLAND												
Maine:												
Portland	0	0	------	0	38	0	3	1	10	0	0	2
New Hampshire:												
Concord	0	0	------	0	------	0	4	0	0	0	0	------
Vermont:												
Barre	0	0	------	0	------	0	0	0	0	0	0	1
Massachusetts:												
Boston	18	0	------	0	18	1	4	1	16	0	0	38
Fall River	0	0	------	0	------	0	0	0	3	0	0	2
Springfield	2	0	------	0	1	0	0	0	5	0	0	5
Worcester	0	0	------	0	3	0	11	0	7	0	0	28
Rhode Island:												
Providence	1	0	------	0	15	0	5	0	14	0	0	26
Connecticut:												
Bridgeport	0	0	------	0	1	0	0	0	0	0	0	------
New Haven	0	0	------	0	44	0	0	0	0	0	0	1
MIDDLE ATLANTIC												
New York:												
Buffalo	3	0	------	0	1	0	5	0	7	0	0	6
New York	24	2	6	3	36	2	61	4	65	0	3	46
Rochester	0	0	------	1	1	0	4	0	8	0	0	1
Syracuse	0	0	------	1	------	0	3	0	8	0	0	27
New Jersey:												
Camden	0	0	------	0	1	1	1	0	0	0	0	3
Newark	0	0	2	0	2	0	3	0	10	0	0	21
Trenton	1	0	------	0	21	0	2	0	1	0	1	1
Pennsylvania:												
Philadelphia	5	0	5	1	6	1	15	1	22	0	1	31
Pittsburgh	1	0	------	0	284	1	7	0	17	0	0	3
Reading	1	0	------	0	------	0	0	0	1	0	0	3
EAST NORTH CENTRAL												
Ohio:												
Cincinnati	2	0	------	0	------	0	5	0	13	0	0	7
Cleveland	0	0	1	0	82	2	5	1	29	0	0	10
Columbus	4	0	------	0	1	1	5	0	10	1	0	3
Indiana:												
Fort Wayne	2	0	------	0	3	0	2	0	0	0	0	------
Indianapolis	1	0	------	0	------	1	6	0	7	0	0	19
South Bend	0	0	------	0	------	0	0	0	4	0	0	------
Terre Haute	0	0	------	0	------	0	1	0	1	0	0	------
Illinois:												
Chicago	1	0	4	2	8	0	18	1	54	0	0	58
Michigan:												
Detroit	0	0	1	0	4	0	10	0	46	0	0	49
Flint	0	0	------	0	1	0	4	0	4	0	0	2
Grand Rapids	0	0	------	0	1	0	2	0	7	0	2	4
Wisconsin:												
Kenosha	0	0	------	0	------	0	0	0	2	0	0	------
Milwaukee	0	1	------	0	9	3	4	0	8	0	0	29
Racine	0	0	------	0	------	0	0	0	3	0	0	4
Superior	1	0	------	0	------	0	0	0	0	0	0	------
WEST NORTH CENTRAL												
Minnesota:												
Duluth	1	0	------	0	------	0	1	1	1	0	0	4
Minneapolis	3	0	------	0	1	0	5	0	9	0	0	2
Missouri:												
Kansas City	1	0	------	0	------	0	4	1	2	0	0	5
St. Joseph	0	0	------	0	------	0	0	0	0	0	0	6
St. Louis	2	0	2	0	5	0	8	1	10	0	0	5

[1] In some instances the figures include nonresident cases.

City reports for week ended Dec. 21, 1946—Continued

Division, State, and city	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
WEST NORTH CENTRAL—continued												
Nebraska:												
Omaha	0	0	------	0	1	0	2	0	1	0	0	------
Kansas:												
Topeka	1	0	------	0	------	0	0	0	0	0	0	0
Wichita	0	0	------	0	1	0	3	0	1	0	0	------
SOUTH ATLANTIC												
Delaware:												
Wilmington	0	0	------	0	------	0	1	0	3	0	0	2
Maryland:												
Baltimore	7	0	1	0	8	0	7	0	5	0	0	40
Cumberland	0	0	------	0	1	0	0	0	0	0	0	------
Frederick	0	0	------	0	------	0	0	0	0	0	0	------
District of Columbia:												
Washington	1	0	1	0	17	0	3	1	4	0	2	4
Virginia:												
Lynchburg	0	0	------	0	------	0	1	0	1	0	0	1
Richmond	2	0	------	0	30	1	1	0	5	0	0	------
Roanoke	0	0	------	0	------	0	0	0	3	0	0	------
West Virginia:												
Wheeling	0	0	------	0	------	0	0	0	0	0	0	2
North Carolina:												
Raleigh	0	0	------	0	------	0	2	0	0	0	0	3
Wilmington	0	0	------	0	------	0	2	0	0	0	0	------
Winston Salem	0	0	------	0	34	0	1	0	0	0	0	------
South Carolina:												
Charleston	0	0	23	0	------	0	0	0	1	0	0	------
Georgia:												
Atlanta	1	0	9	4	7	0	5	0	2	0	0	2
Brunswick	0	0	------	0	------	0	1	0	0	0	0	------
Savannah	0	0	------	1	13	0	2	0	0	0	0	------
Florida:												
Tampa	3	0	1	0	------	2	1	0	2	0	1	2
EAST SOUTH CENTRAL												
Tennessee:												
Memphis	1	0	------	1	------	2	12	1	2	0	0	2
Nashville	3	0	------	0	------	1	0	0	1	0	0	------
Alabama:												
Birmingham	2	0	8	0	4	1	2	0	5	0	1	------
Mobile	0	0	17	1	5	0	1	0	0	0	0	------
WEST SOUTH CENTRAL												
Arkansas:												
Little Rock	0	0	------	0	2	0	0	0	1	0	0	------
Louisiana:												
New Orleans	4	0	2	3	5	0	6	1	3	0	0	------
Shreveport	0	0	------	0	------	0	3	0	0	0	0	------
Texas:												
Dallas	0	0	------	1	------	0	1	0	3	0	0	2
Galveston	2	0	------	0	------	0	0	0	0	0	0	------
Houston	0	0	------	0	------	0	3	1	2	0	0	------
San Antonio	3	0	------	0	------	0	8	0	0	0	0	1
MOUNTAIN												
Montana:												
Billings	0	0	------	0	------	0	1	0	0	0	0	------
Great Falls	0	0	------	0	------	0	0	0	1	0	0	------
Helena	0	0	------	0	1	0	0	0	0	0	0	------
Missoula	0	0	------	0	4	0	0	0	0	0	0	------
Colorado:												
Denver	9	0	4	0	2	0	8	0	14	0	0	3
Pueblo	2	0	------	0	------	0	0	0	1	0	0	------
Utah:												
Salt Lake City	3	0	------	0	1	0	4	0	3	0	0	------

City reports for week ended Dec. 21, 1946—Continued

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
PACIFIC												
Washington:												
Seattle	0	0		0	4	1	2	0	5	0	0	4
Spokane	0	0		0	2	0	0	0	2	0	0	
Tacoma	0	0		0		0	1	0	1	0	0	
California:												
Los Angeles	6	0	4	0	6	1	4	8	19	0	0	10
Sacramento	1	0	1	1	2	0	3	0	2	0	0	1
San Francisco	0	0	1	0	3	0	2	0	11	0	0	
Total	125	3	93	20	740	22	301	24	508	1	11	531
Corresponding week, 1945	95		1,740	80	808		496		582	0	8	425
Average 1941–45	79		1,501	[2] 139	[3] 995		[2] 674		888	0	10	837

[2] 3-year average, 1943–45.
[3] 5-year median, 1941–45.

Dysentery, amebic.—Cases: Buffalo 1; New York 8; Newark 1; Chicago 2; Spokane 1; Los Angeles 1.
Dysentery, bacillary.—Cases: Charleston, S. C., 2; Los Angeles 5; San Francisco 1.
Dysentery, unspecified.—Cases: San Antonio 8.
Leprosy.—Cases: New Orleans 1.
Rocky Mountain spotted fever.—Cases: Baltimore 1.
Tularemia.—Cases: St. Louis 4; Washington, D. C., 1.
Typhus fever, endemic.—Cases: Atlanta 1; Savannah 1; Mobile 1; New Orleans 1.

Rates (annual basis) per 100,000 population, by geographic groups, for the 84 cities in the preceding table (estimated population, 1943, 33,737,700)

	Diphtheria case rates	Encephalitis, infectious, case rates	Influenza		Measles case rates	Meningitis, meningococcus, case rates	Pneumonia death rates	Poliomyelitis case rates	Scarlet fever case rates	Smallpox case rates	Typhoid and paratyphoid fever case rates	Whooping cough case rates
			Case rates	Death rates								
New England	60.1	0.0	0.0	0.0	344	2.9	77.3	5.7	158	0.0	0.0	295
Middle Atlantic	16.2	0.9	6.0	2.8	163	2.3	46.7	2.3	64	0.0	2.3	66
East North Central	6.7	0.6	3.7	1.2	67	4.3	38.0	1.2	115	0.6	1.2	113
West North Central	18.0	0.0	4.5	0.0	18	0.0	51.8	6.8	54	0.0	0.0	50
South Atlantic	23.4	0.0	58.6	8.4	184	5.0	45.2	1.7	44	0.0	5.0	94
East South Central	35.4	0.0	147.5	11.8	53	23.6	88.5	5.9	47	0.0	5.9	12
West South Central	25.8	0.0	5.7	11.5	20	0.0	60.3	5.7	26	0.0	0.0	9
Mountain	115.6	0.0	33.0	0.0	66	0.0	107.4	0.0	157	0.0	0.0	25
Pacific	11.1	0.0	9.5	1.6	27	3.2	19.0	12.7	63	0.0	0.0	24
Total	19.4	0.5	14.4	3.1	115	3.4	46.6	3.7	79	0.2	1.7	82

TERRITORIES AND POSSESSIONS

Puerto Rico

Notifiable diseases—4 weeks ended November 30, 1946.—During the 4 weeks ended November 30, 1946, cases of certain notifiable diseases were reported in Puerto Rico as follows:

Disease	Cases	Disease	Cases
Chickenpox	3	Syphilis	130
Diphtheria	41	Tetanus	6
Dysentery, unspecified	5	Tetanus, infantile	1
Gonorrhea	128	Tuberculosis (all forms)	590
Influenza	167	Typhoid and paratyphoid fever	5
Malaria	566	Typhus fever (murine)	5
Measles	4	Whooping cough	155
Poliomyelitis	36		

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended December 7, 1946.—During the week ended December 7, 1946, 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		29		160	405	41	62	99	174	970
Diphtheria		2		43	17	4	1	2		69
Dysentery:										
Amebic					5					5
Bacillary				1						1
Encephalitis, infectious					1					1
German measles				5	15			11	7	38
Influenza					3	2			1	6
Measles		573		137	81	57	378	173	126	1,525
Meningitis, meningococcus			1	1	1	1	3			7
Mumps		1		45	292	35	99	24	200	696
Poliomyelitis		2		7	8			1		18
Scarlet fever		8	6	86	114	6	2	3	17	242
Tuberculosis (all forms)		10	21	122	62	40	11	40	48	354
Typhoid and paratyphoid fever				3	1				2	6
Undulant fever				1						1
Venereal diseases:										
Gonorrhea		9	17	130	106	40	32	57	92	483
Syphilis		14	12	94	90	11	11	9	38	279
Other forms									4	4
Whooping cough		2	1	70	101	8	4	5	8	199

FINLAND

Notifiable diseases—October 1946.—During the month of October 1946, cases of certain notifiable diseases were reported in Finland as follows:

Disease	Cases	Disease	Cases
Cerebrospinal meningitis	9	Poliomyelitis	48
Diphtheria	1,262	Scarlet fever	190
Dysentery	16	Syphilis	551
Gonorrhea	1,805	Typhoid fever	44
Paratyphoid fever	436		

NEW ZEALAND

Notifiable diseases—4 weeks ended November 2, 1946.—During the 4 weeks ended November 2, 1946, certain notifiable diseases were reported in New Zealand as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Cerebrospinal meningitis	12		Poliomyelitis	1	
Diphtheria	75	1	Puerperal fever	8	
Dysentery:			Scarlet fever	106	
Amebic	1		Tetanus	2	
Bacillary	5		Trachoma	3	
Erysipelas	13		Tuberculosis (all forms)	218	80
Food poisoning	31	1	Typhoid fever	6	
Malaria	3		Undulant fever	2	

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

NOTE.—Except in cases of unusual incidence, only those places are included which had not previously reported any of the above-named diseases, except yellow fever, during recent months. 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 of each month.

Plague

Brazil—Minas Geraes State—Serro.—During the month of December 1946, 12 cases of plague were reported in Serro, Minas Geraes State, Brazil.

Manchuria—Harbin.—For the period July 1 to November 8, 1946, 264 cases of plague were reported in Harbin, Manchuria.

Smallpox

China—Hong Kong.—For the week ended December 14, 1946, 162 cases of smallpox were reported in Hong Kong, China.

Colombia.—For the month of November 1946, 165 cases of smallpox with 4 deaths were reported in Colombia. Departments reporting the highest incidence are: Narino, 86 cases; Huila, 27 cases, 2 deaths; Santander, 19 cases; Cundinamarca, 18 cases, 2 deaths.

Ecuador.—For the month of November 1946, 28 cases of smallpox with 2 deaths were reported in Ecuador, including 23 cases reported in Babahoya, Los Rios Province, Ecuador.

Typhus Fever

Colombia.—For the month of November 1946, 218 cases of typhus fever with 8 deaths were reported in Colombia. Departments reporting the highest incidence are: Narino, 68 cases, 4 deaths; Cundinamarca, 48 cases, 1 death; Santander, 27 cases; Caldas, 23 cases; Magdalena, 15 cases; Huila, 12 cases.