**Table II. Annual Summary of Notifiable Diseases***

| | |
|---|---|
| Amebiasis | Q-fever |
| Anthrax | Rabies in man |
| Botulism | Rabies in animals |
| Brucellosis | Rocky Mountain spotted fever |
| Cholera | Salmonellosis |
| Dengue | Shigellosis |
| Diphtheria | Smallpox |
| Glanders | Streptococcal sore throat including scarlet fever |
| Infectious encephalitis (by etiology if known) | Tetanus |
| Infectious hepatitis, including serum hepatitis | Trachoma |
| Leprosy | Trichinosis |
| Leptospirosis | Tuberculosis (all forms) |
| Malaria | Tularemia |
| Measles | Typhoid fever |
| Meningococcal meningitis and meningococcemia | Typhus fever, endemic |
| Pertussis (whooping cough) | Typhus fever, epidemic |
| Plague | Yellow fever |
| Poliomyelitis | Venereal diseases |
| Paralytic | Chancroid |
| Non-paralytic | Gonorrhea |
| Unspecified | Granuloma inguinale |
| Psittacosis | Lymphogranuloma venereum |
| | Syphilis |
| | Primary and secondary |
| | All other |

*All diseases for which laboratory confirmations are available are to be reported by (1) Total Cases, and (2) Total Laboratory confirmed cases.

# A SURVEY TO DETERMINE THE PREVALENCE AND DISTRIBUTION OF TYPHUS IN RATS IN TEXAS

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## INTRODUCTION

The problem of typhus control in Texas and in the Nation has been the concern of public health personnel for some years. In 1945, the Texas State Department of Health started an extensive typhus control program with operational policies based primarily on the incidence of murine typhus fever in humans. This program consisted of dusting rat runs and harborages with 10 percent DDT plus rat poisoning. Ratproofing was begun in a few cities prior to 1945. In this beginning year, a large protion of the 1,844*** human typhus cases

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***Data on the incidence of reported human typhus cases furnished by the Bureau of Vital Statistics, Texas State Department of Health.

was reported from the southern part of the State, but every section reported some cases.

During the first years of typhus control operations, human typhus cases were widespread and the rat populations were universally heavy. By carrying on typhus vector and rodent control programs in counties reporting the larger number of cases, and by operating mostly in the urban areas, the incidence of human cases was reduced from 1,844 cases in 1945 to 222 in 1950. Because of this 88 percent reduction of human cases, and in order to concentrate on the remaining scattered typhus foci, it was apparent that future control operations should be carefully planned.

## OBJECTIVES

It was deemed desirable to secure more definite information about the accomplishments of 5 years of operations, as well as to obtain the necessary biological data to plan future typhus control operations. Surveys were accordingly planned in 1951 with two major objectives in mind: (1) to compare the 1946 and 1951 infection rates of murine typhus in rats trapped from certain selected counties;* and (2) to determine the extent and distribution of rats with typhus antibodies by certain premises categories and by climatical and geographical areas. The premises categories selected were: $B_1$—human food handling establishments; $B_2$—feed stores, grain houses, and warehouses; $B_3$—other businesses not handling food or feed, as well as residences and farms.

## SURVEY OPERATIONS

The survey operational organization, as in the previous years, was as follows: (1) directed by the Texas State Department of Health; (2) laboratory work by the Texas Bureau of Laboratories; (3) promotion and field supervision by district engineers assisted by district supervisors; and (4) local operations carried on by State and local typhus control personnel.

In planning the operations for the two major objectives, it was decided to secure a minimum of one or more rats (later changed to two or more) from at least 50 well-distributed premises in each of the counties to be surveyed. Approximately 50 percent of the surveyed premises were to be located in urban areas and the other half in the rural areas of each county.

Since many urban typhus control programs were organized and local assistance was available, the accomplishment of urban evaluation work could be expected. However, with few local rural typhus control personnel to assist in the rural surveys, the idea of using high school agricultural students was successfully tried in Karnes County in December of 1950. The procedure used in conducting the rodent control and rat trapping project was later carried out on a State-wide basis. During the latter half of the 1950-51 school year, 45 different vocational agriculture classes comprising 2,060 students trapped 1,293 rats.

The 4-day typhus and rodent control training and trapping course was conducted as follows:

First day: Recognition of rat signs and live rat trapping was taught. Each student was assigned 15 steel rat traps at the close of the lecture and each boy started his individual 3-night trapping project at his or his neighbor's farm.

Second day: Rodent-borne diseases were discussed. Bleeding of rats, centrifuging the rat blood, and examination of the rats for ectoparasites were demonstrated to the students.

Third day: Lecture on methods of dusting rat runs and harborages to control rat fleas that transmit typhus, and also the principles of rat poisoning.

Fourth day: Antirat sanitation and ratproofing.

Teaching aids such as filmstrips, 16 mm. movie films, charts, and demonstrations were used extensively. The local vocational agriculture teacher and a representative of the State department of health conducted each of the classes. As a precautionary measure, each student dusted the trapped rats with DDT several minutes before handling. The trapped rats were then placed in containers (usually quart fruit jars), and were delivered each morning to the school building where the typhus control representative bled each rat, centrifuged the blood, and mailed the rat serum to the State laboratory to be tested for typhus complement-fixing antibodies.

## COMPARISON OF THE 1946 AND 1951 RATES OF TYPHUS INFECTION IN RATS

To accomplish the first objective of comparing the typhus infection rate in rats in 1946 with that of 1951, eight counties were surveyed. The

*A limited amount of rat trapping was done in Texas during the latter part of 1945. The survey information secured during 1945 is included in the 1946 data for this paper.

A group of high school agricultural students watching a typhus control technician bleed rats which they had trapped from their farms. The 36 boys in this Future Farmers of America chapter trapped 80 rats in three nights.

*Photo courtesy of Texas State Department of Health.*

comparative findings are shown graphically in figure 1.

In 1946, rats from 495 premises were successfully tested from the eight survey counties represented in figure 1. Of these tested premises, 211, or 42 percent, were found to have rats with typhus antibodies. Five hundred and eighty premises in the same counties had rat serums successfully tested in 1951, and only 84 of these premises, or 14 percent, were found to have rats positive to the typhus complement fixation test. By comparing the 1946 typhus infection rate in rats with the 1951 rate, a 67 percent reduction was indicated for the 5-year period.

The 495 premises of the 1946 survey were represented by 1,165 successfully tested rat serums, or an average of 2.3 rats per premises. There were 908 rat bloods successfully tested from 580 premises in 1951, or an average of 1.5 rats per premises.

Since emphasis was placed on urban typhus control in Texas during the 5 years of operations, information from two cities located in two survey counties is given in more detail for illustrative purposes. Corpus Christi, Nueces County, has been selected as an example to show apparent progress in the reduction of the incidence of typhus in rats, while data from San Antonio, Bexar County, are given to show the lack of material reduction of the incidence of typhus in rats. Table 1 contains data concerning the surveys conducted in Corpus Christi.

In the statistics given in table 1, it is noted that 87 percent of the food establishments, 97 percent of the feed stores and warehouses, 72

FIGURE 1
PERCENTAGE OF PREMISES WITH TYPHUS POSITIVE RATS IN 1946 COMPARED WITH 1951

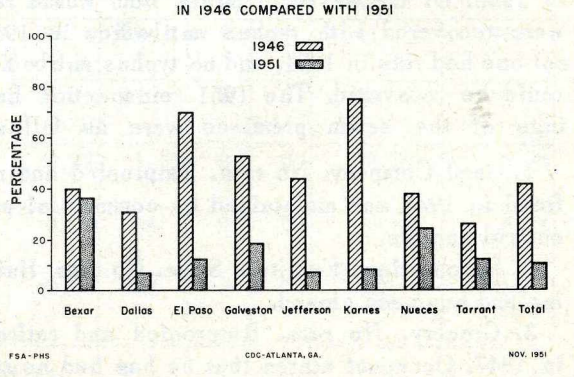


Table 1

TYPHUS INFECTION RATES FOUND IN RATS, AND OTHER SURVEY DATA FOR CORPUS CHRISTI, NUECES COUNTY, DURING THE YEARS 1946 AND 1951

| | 1946* | | | | | 1951* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $B_1$** | $B_2$*** | $B_3$† | Residences | Total | $B_1$ | $B_2$ | $B_3$ | Residences | Total |
| No. of Premises Inspected | 372 | 71 | 672 | 19,338 | 20,453 | 57 | 15 | 52 | 180 | 304 |
| Premises Rat-Infested | 323 | 69 | 485 | 1,211 | 2,088 | 6 | 2 | 1 | 5 | 14 |
| % Premises Rat Infested | 87% | 97% | 72% | 6.3% | 10% | 11% | 13% | 2% | 3% | 5% |
| Premises Trapped | 30 | 9 | 5 | 29 | 73 | 5 | 2 | 1 | 3 | 11 |
| Premises Rat Serums Tested | 15 | 5 | 1 | 16 | 37 | 5 | 2 | 1 | 3 | 11 |
| Premises with Positive Rats | 3 | 1 | 1 | 2 | 7 | 0 | 0 | 0 | 0 | 0 |
| % of Premises Inspected with Positive Rats | 0.8% | 1.4% | 0.15% | 0.01% | 0.03% | 0 | 0 | 0 | 0 | 0 |
| % of Rat-Infested Premises with Positive Rats | 0.9% | 1.4% | 0.2% | 0.17% | 0.34% | 0 | 0 | 0 | 0 | 0 |
| % of Serums Tested Premises Positive | 20% | 20% | 100% | 12.5% | 19% | 0 | 0 | 0 | 0 | 0 |

*The breakdowns of business establishments are estimates.
**$B_1$ - Food Establishments.
***$B_2$ - Feed and Seed Stores, and Warehouses.
†$B_3$ - Other Businesses, Nonfood, Nonfeed, and Nonseed Houses.

percent of the nonfood and nonfeed stores, and 6.3 percent of the residences were rat-infested in 1946. During 1951, the premises inspections were made for evaluation purposes; thus the number of inspections was not nearly as large as for 1946. However, 304 premises that were most likely to be rat-infested were inspected and only 14 of these premises, or 4.6 percent, were found to have rats.

Nineteen percent of the tested premises in Corpus Christi had typhus positive rats in 1946, while none was found to have rats with typhus antibodies in 1951. It is questionable that typhus in rats was completely absent in Corpus Christi in 1951, but the reduction in the prevalence was further confirmed by the survey findings of those premises that were found to have positive rats in 1946. Of the seven premises from which rats were recovered with typhus antibodies in 1946, not one had rats in 1951, and no typhus antibodies could be recovered. The 1951 reinspection findings of the seven premises were as follows:

1. Seed Company. No rats. Ratproofed and ratfreed in 1947 and maintained by commercial pest control service.

2. Second Hand Furniture Store. No rats. Building and business closed.

3. Grocery. No rats. Ratproofed and ratfreed in 1947. Occupant states that he has had no rats since that time.

4. Tortilla Factory. No rats. Ratproofed in 1947 and has had commercial pest control service since that time.

5. Super Market. No rats. Corrected by replacing old building with a new, modern, brick, ratproofed building.

6. Residence, 700 block Alameda. No rats. Corrections made previous to 1951 by removal of chickens and feed from premises.

7. Residence, 3500 block Blue Bonnet. No rats. Corrected previous to 1951 by removal of chickens and feed from premises.

In general, the reduction of rats and of the prevalence of typhus in rats in Corpus Christi can be attributed to the following:

1. Semiannual DDT dusting of rat runs and harborages in rat-infested business buildings and annual DDT dusting in the residential area.

2. Ratproofing with emphasis on foodhandling establishments. Cafes and grocery stores were required to be ratproofed and ratfree in order to receive an annual permit to operate.

3. Rat reduction by poisoning in all business and residential establishments throughout the city.

4. All cafe and grocery store operators were strongly encouraged to continue using the services of the commercial pest control operator.

5. Antirat sanitation: Extensive phases of anti-

rat sanitation were carried on throughout the residential and business areas and the sanitary landfill method of garbage disposal was begun in 1946.

6. In 1948 an ordinance was passed regulating livestock and animals in the city. Difficulty of enforcement was encountered; nevertheless, apparent progress was made in reducing the rat population in the residential areas.

In brief, the policy followed in the business area of Corpus Christi was to initiate rodent control in all food establishments by ratproofing, rat poisoning, and antirat sanitation, followed by the eradication of rats from the neighboring nonfood establishments. In almost all areas where the food establishments were maintained ratfree, the rate of reinfestation of nonfood and nonfeed handling establishments with rats was very low.

The rural areas and the smaller towns of Nueces County did not conduct as extensive control during the 5 years as was conducted in Corpus Christi. Nueces County reported 59 human typhus cases in 1945 and only 9 cases in 1950. This is a reduction of 85 percent, but the remaining 15 percent can be expected to continue until an effective rural program is activated in Nueces County.

Cameron County, a coastal county similar to Nueces, has conducted an efficient rural typhus control program, and, therefore, its program can be used as a guide for planning rural typhus control work in Nueces County.

The Cameron County program was activated in 1947 with one man to do annual DDT dusting and rat poisoning of all rat-infested farms. In 1947, from a survey of 59 rural premises in Cameron County, 20 premises, or 34 percent of the farms tested, were found to have rats with typhus antibodies. In 1951, rat serums from 85 rural premises were tested and only five farms, or 6 percent, were found to have rats with typhus antibodies. This fact indicates that the typhus infection rate in rats was reduced 82 percent during the 4 years of continuous operations. It thus may be assumed from the Cameron County survey statistics that the prevalence of typhus in rural rats could be materially reduced in Nueces County by carrying on a similar program.

Data concerning the San Antonio surveys are given in table 2.

In table 2, it is shown that the results of the 1951 San Antonio survey were practically the same as in 1946. In 1951, 78 percent of the inspected premises were rat infested, while in 1946, 80 percent were infested. Of the 93 premises from which rat bloods were tested in 1946, rat serums from 37 premises, or 40 percent, were found with typhus complement-fixing antibodies. Of the 75 premises from which rat bloods were

**Table 2**

**TYPHUS INFECTION RATES FOUND IN RATS, AND OTHER SURVEY DATA FOR SAN ANTONIO, BEXAR COUNTY, DURING THE YEARS 1946 AND 1951**

| | 1946* | | | | | 1951 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | Residences | Total | $B_1$ | $B_2$ | $B_3$ | Residences | Total |
| No. Premises Inspected | 730 | 111 | 350 | 4,229 | 5,420 | 707 | 100 | 300 | 3,817 | 4,924 |
| Premises Rat Infested | 271 | 77 | 170 | 3,789 | 4,307 | 207 | 66 | 150 | 3,411 | 3,834 |
| % Premises Rat-Infested | 37% | 69% | 49% | 90% | 80% | 29% | 66% | 50% | 89% | 78% |
| Premises Trapped | 53 | 5 | 22 | 181 | 261 | 33 | 0 | 4 | 46 | 83 |
| Premises Rat Serums Tested | 26 | 4 | 8 | 65 | 93 | 30 | 0 | 4 | 41 | 75 |
| Premises with Positive Rats | 8 | 0 | 0 | 29 | 37 | 11 | 0 | 0 | 18 | 29 |
| % of Premises Inspected with Positive Rats | 1% | 0 | 0 | 0.7% | 0.7% | 1.6% | 0 | 0 | 0.5% | 0.6% |
| % of Rat-Infested Premises With Positive Rats | 3% | 0 | 0 | 0.8% | 0.9% | 5% | 0 | 0 | 0.5% | 0.8% |
| % of Serums Tested Premise: Premises Positive | 31% | 0 | 0 | 45% | 40% | 37% | 0 | 0 | 44% | 39% |

*The breakdowns of business establishments are estimates.

tested in 1951, 39 percent were found to have rats with typhus antibodies.

Some of the rat control measures used in San Antonio were ratproofing in the central business district, rat poisoning in the municipal buildings and grounds, antirat inspection service in food establishments by sanitarians, and the application of rodenticides by commercial pest control operators.

The typhus vector control work in San Antonio largely consisted of one very complete cycle of DDT dusting of rat runs and harborages of the rat-infested business and residential premises in 1945-46. The dusting activity after 1946 was done primarily in business establishments, while the residential area was kept under surveillance for human typhus. Spot dusting was done in the immediate area where typhus cases had occurred. A question of policy prevented the local health unit from doing as extensive control in the residential area as was desired.

A large portion of the rat infestation and the incidence of typhus in rats was found to exist both years in the southwestern section of San Antonio adjacent to the central business district. This area consisted primarily of substandard residences with beer taverns, small grocery stores, and cafes interspersed among the small, poorly constructed, overcrowded homes. The insanitary conditions existing in this area were conducive to the propagation of rats.

In the 1946 San Antonio survey, there was an average of eight fleas of the species *Xenopsylla cheopis* recovered per rat, while in 1951 there was an average of two oriental rat fleas per rat. Of the premises from which rats were trapped in 1946, 40 percent yielded rats with *X. cheopis*, whereas 45 percent of the premises yielded rats with *X. cheopis* in 1951.

In 1946, there were 37 human cases of typhus fever reported from San Antonio, Bexar County, while in 1950 only 1 case was reported. The reduction was 97 percent in the number of reported human typhus cases, but due to the fact that 39 percent of the rat serums tested premises had typhus positive rats, with an average infestation of two *X. cheopis* per rat, it was apparent that conditions were existing in San Antonio which might cause an unlimited number of human cases to occur during 1951. As a result of the survey findings, extensive DDT dusting of the rat-infested premises throughout the substandard area was carried out. Rat poisoning with warfarin was also done in premises with heaviest rat infestations.

The survey findings in San Antonio support the thesis that sporadic DDT dusting will temporarily reduce the prevalence of typhus in humans, but rat control, including antirat sanitation, rat poisoning, and ratproofing, combined with an efficient DDT dusting program, are all necessary in the reduction of murine typhus in the rats.

## THE DISTRIBUTION AND RATES OF TYPHUS INFECTION FOUND AMONG RATS IN 1951

To attain the second objective, namely, to determine the extent and distribution of rats with typhus antibodies, Texas was divided into four geographical zones which are described as follows:

Zone I, Coastal: All the counties adjacent to the Gulf of Mexico are included in this zone. The altitude in the counties varies from 0 to 200 ft.; the rainfall varies from 20 in. annually in the southern portion to 50 in. in the east; the relative humidity usually averages about 70 percent; and the average temperature is 69° F. Agricultural activities in this area include vegetable raising by irrigation in the south; cotton, grain, and cattle raising in the central counties; and rice farming in the eastern counties.

Zone II, Inter-Coastal Plains: This zone includes a wide section of counties extending from southwest to northeast. The altitude varies from 50 to 1,500 ft.; the rainfall, from 20 in. in the south to 50 in. in the east; the relative humidity averages 66 percent; and the temperature average is 67° F. Agricultural activities through this section consist largely of raising cotton, small grain, corn, cattle, and hogs.

Zone III, North Central Plains: This area is northwest of the Burnet-Llano Hill country near Austin, and extends to the Great Plains. The altitude varies from 900 to 2,600 ft.; the rainfall is 10 to 30 in.; the relative humidity averages 60 percent; and the temperature average is 65° F. Cattle grazing is the predominant agricultural activity with some farming, mostly in the northern section.

Zone IV, El Paso and Great Plains: This area comprises the most western and northern sections of the State. The altitude varies from 3,000 to 7,100 ft.; the rainfall is 10 to 25 in.; the relative humidity averages 48 percent and the average temperature is 58° F. Agricultural activities include cattle grazing and raising of cotton and small grain.

during the extremely dry and hot summer months and additional data is needed before reliable conclusions can be made.

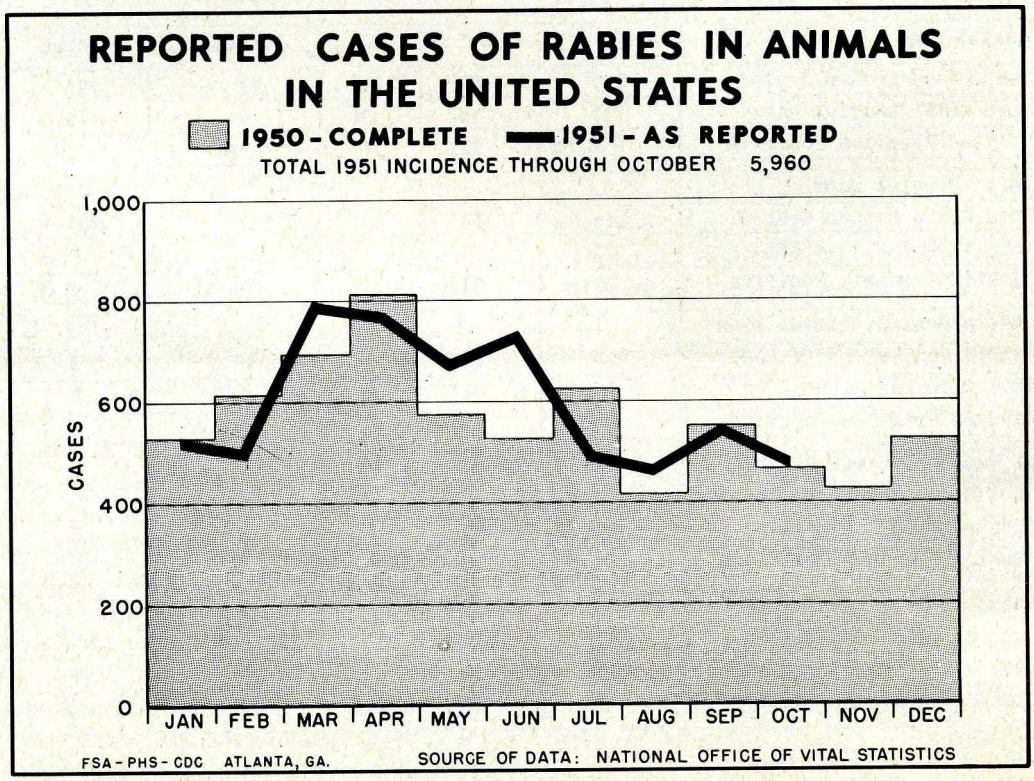
## SUMMARY

The objectives of this paper, as stated at the beginning, were twofold: (1) To compare the 1946 murine typhus infection rate in rats found in Texas with the 1951 rate; and (2) To determine the extent and distribution of rats having typhus antibodies according to certain premises categories by climatical and geographical areas. The survey work was accomplished by Texas CDC personnel, local typhus control personnel, and the Future Farmers of America.

In comparing the 1946 and 1951 typhus infection rates in rats in Texas, eight counties were included in the survey. In 1946, 42 percent of the premises from which rat serums were tested had one or more rats with typhus antibodies, whereas in 1951, only 14 percent of similar premises were found to have positive rats. No county survey failed to show a reduction in typhus prevalence. Karnes County was shown to have the highest typhus infection rate in rats in 1946, but this rate was reduced from 75 percent in 1946 to 8.7 percent in 1951, a reduction of 88 percent.

In comparing the two surveys, it is shown that the reduction of the prevalence of typhus in rats was much more noticeable in counties or areas where different phases of extensive rat control were carried on in addition to 10 percent DDT dusting.

To determine the 1951 typhus infection rate in rats, the State was divided into four geographical areas and from 4 to 19 counties were surveyed in each zone. In Zone I, which contained the counties adjacent to the Gulf of Mexico, 12 percent of all types of urban and rural establishments were found to have rats with typhus antibodies. A major portion of the State's rural rat typhus was found existing in this zone. Typhus rat reservoirs were found in all types of urban and rural premises in Zone II, which comprises approximately half of the southern inland portion of the State. Thirteen percent of the premises surveyed had typhus positive rats. In Zones III (North Central) and IV (El Paso and Great Plains) combined, only three premises were found to have rats with typhus complement fixation antibodies, and the titers were low in all cases.





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