An Outbreak of Endemic Typhus Fever in Nashville, Tennessee

Its Epidemiology and Control

C. B. TUCKER, M.D., THOMAS V. WOODRING, M.D., AND HARRY C. ESSICK

Director, Division of Preventable Diseases, Tennessee Department of Public Health; Assistant Health Officer, Nashville, Tenn.; and Senior Sanitary Inspector, U. S. Public Health Service, Savannah, Ga.

ENDEMIC typhus fever is known to have been present in the southeastern states as early as 1913. Dyer [1] has indicated that the gradual increase in the number of reported cases in southern states from 1923 to 1931 might be explained by increased recognition of cases by physicians but that the sharp increases in 1932 and 1933 surely could not be explained on those grounds alone. As pointed out by Dyer [1] and by Baker, McAlpine, and Gill,[2] the disease since 1929 has shown a tendency to spread inland from the Atlantic and Gulf coastal cities.

The first case of endemic typhus reported in Tennessee was in 1926 as shown in Table 1. Prior to 1925 no records of morbidity were kept by the Tennessee Department of Public Health and, therefore, nothing is known as to the occurrence of cases before that year. Some doubt may be raised as to the accuracy of diagnosis or as to the source of the infection in 6 of 9 cases reported during the period 1926–1934. Prior to 1934 no separate account was kept of nonresident cases. Three cases reported between 1926 and 1934 were known to be nonresident cases.

TABLE 1

Endemic Typhus Fever Cases Reported in Tennessee, 1926–1939

Year	*Number*	*Year*	*Number*
1926	1	1933	1
1927	0	1934	0
1928	2	1935	8
1929	2	1936	6
1930	0	1937	21
1931	1	1938	24
1932	2	1939	100

Among the 159 cases reported during the period 1935–1939, 28 were reported from strictly rural regions and may not have been endemic typhus fever. In 1939, 8 cases reported from rural areas as endemic typhus fever were found upon investigation to be: Rocky Mountain spotted fever in 6 instances, tularemia in 1 instance, and a Salmonella infection in 1 instance. These misdiagnosed cases give sufficient reason to doubt the diagnosis of a number of cases reported in the past as endemic typhus fever.

FEATURES OF THE OUTBREAK

A considerable outbreak of typhus fever occurred in Nashville in the autumn of 1939. Nashville serves as a freight terminal on the Cumberland River and, besides being a river terminal, it is an important railway center

for three railroads and is a trade center for central Tennessee, south-central Kentucky, and northern Alabama. There are various local industries, among which are grain mills, feed mills, wholesale groceries, and other establishments handling foodstuffs of different kinds. The estimated population of Nashville for July 1, 1939, was 166,312. Of this number 120,006 (72 per cent) were white, and 46,306 (28 per cent) colored.

Incidence—In 1935 endemic typhus fever was first definitely diagnosed and reported among residents of Nashville, 6 cases being reported that year. In Figure 1, there are three areas marked 1, 2, and 3 which represent probable foci of endemic typhus infection among rats. Four of the 6 cases in 1935 occurred among employees of a large feed mill in Area 1 and among residents of the immediate vicinity. The mill is located adjacent to the main lines of the Nashville, Chattanooga, and St. Louis and the Louisville and Nashville Railroads, a short distance north from where the two railroads converge and extend to the freight and passenger terminals. It seems reasonable to believe that infected rats were on freight cars entering the city from the south, and left the train to feed or were unloaded with bulk grain at this mill. Subsequently, a definite focus was established among rats having harborage in the mill and its immediate vicinity. It is probable that this was the first focus to be established in Nashville. However, infected rats had probably extended to other areas before cases occurred or were recognized in Area 1, because 2 other cases were reported in 1935 in individuals whose place of employment was just north of Area 2.

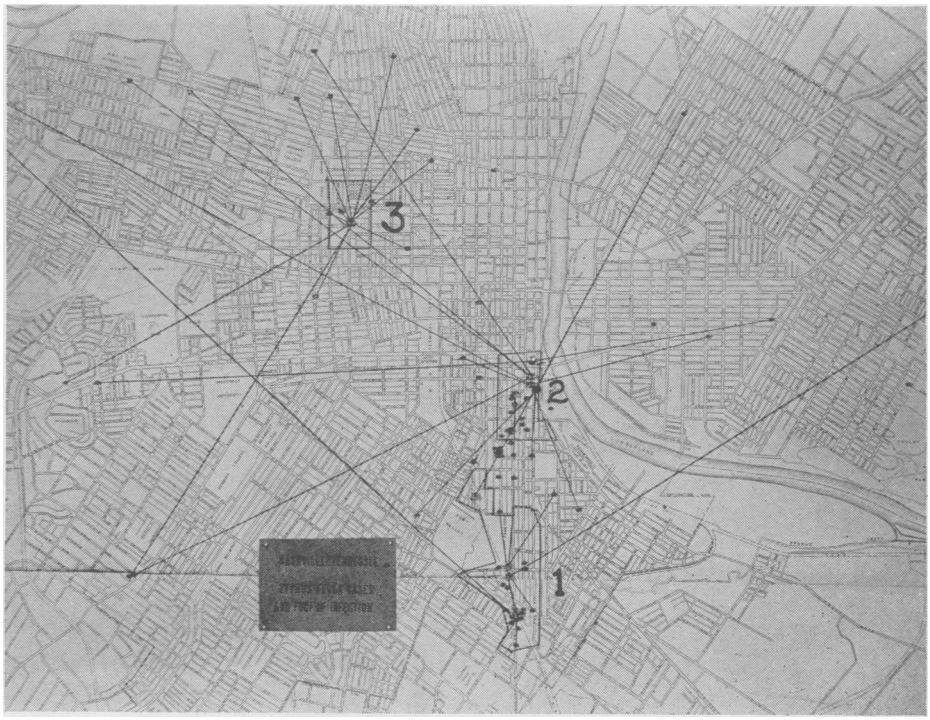

FIGURE 1—Typhus fever in Nashville, Tenn., during 1939. Black dots represent residences of cases. Lines extend from residences of cases to foci of infection. Three areas are marked denoting location of intensive rat control measures.

In 1936, 2 cases were reported among employees of the mill in Area 1, and 1 other case in a person whose place of employment was just north of Area 2. In 1937, 13 cases were reported in the city. Two of these were employees of the same mill in Area 1, and 3 were residents of the immediate vicinity. Six cases were reported in employees of a feed mill in Area 2, with probable source of the remaining cases unknown. Of the 9 cases reported in 1938, 2 were employees of a poultry house in Area 2, and 7 were employees of two grain mills in Area 1. During 1939, 75 cases of endemic typhus fever were reported to the City Health Department. In addition, 5 cases in persons living in Davidson County outside the city gave histories which suggested that their source of infection was in Nashville.

Seasonable Distribution—The dates of onset, by months, of the cases reported in 1939 were as follows:

January	3
July	1
August	1
September	20
October	23
November	24
December	3

From these figures it is seen that 67 of the 75 cases occurred in September, October, and November. In states to the south and southeast [2, 3] the first cases have usually been seen in June or July, the incidence reaching a peak in September, followed by a decline in October and November. Perhaps some differences in temperature, humidity, or a combination of factors affecting the rat flea play a part in the later seasonal incidence of the disease in Tennessee.

Geographical Distribution—The place of residence for each case reported during 1939 is spotted on the map (Figure 1). The probable source of infection is indicated by lines extending from the residences to the different foci. No lines are seen extending from the residences within each area or from residences of patients where no source of infection could be determined. By careful history taking it was possible to determine the probable source of infection in 70 of the 75 cases.

Occupational Influence — The cases for which the source of infection could be determined were either in employees at or in visitors to grain mills, seed stores, groceries, restaurants, and poultry houses, or among persons living or working in buildings in the immediate vicinity of such places which offered generally good harborage for rats.

Two of the cases were in persons whose occupation was that of commercial rat exterminator. Another case was in a policeman whose area of duty was in a residential section of the city but who spent several hours each Saturday morning in a barber shop which was adjacent to a poultry house in Area 2. Two barbers working in this shop had the disease at about the same time as the policeman.

TABLE 2

Distribution by Color, Sex, and Age of Cases of Endemic Typhus Fever Reported in Nashville, Tenn., in 1939

	Total		*White*		*Colored*	
Age Group	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
All Ages	55	20	43	17	12	3
0– 9 years	1	1	1	1	0	0
10–19 years	2	2	2	2	0	0
20–29 years	13	5	12	4	1	1
30–39 years	12	2	10	2	2	0
40–49 years	10	4	6	4	4	0
50–59 years	12	4	8	4	4	0
60–69 years	5	1	4	0	1	1
70 years and over	0	1	0	0	0	1

Color, Sex, and Age Distribution—Table 2 gives the color, sex, and age distribution of the cases. Sixty (80 per cent) of the cases occurred in white persons, and 15 (20 per cent) in Negroes. This is a rate of 50 per 100,000 population for whites and a rate of 32.4 per 100,000 population for Negroes.

In order to have a complete record of cases, the employers of the major food-handling establishments in the three areas were requested to report absences from work. Visits were made to the homes of employees when reports were received. Twelve cases among Negroes were found by these investigations. Of the 12 cases, 5 were not under the care of a physician. The others had been seen by physicians and their illness diagnosed as typhoid fever, malaria, influenza, or some other condition.

Twenty-one cases, 9 of which were white, and 12 colored, occurred among employees of four large feed mills These mills employ 334 persons, 119 of whom are white, and 215 colored. The attack rates in this small population were 7.6 per cent among the white employees, and 5.6 per cent among the colored employees. Although no general conclusion can be drawn from these figures, it appears that here the incidence of the disease was nearly as high among the colored race as among the white race.

The mild manifestations of the disease and the lack of medical care may be responsible for failure to diagnose and report some cases among Negroes. Baker, McAlpine, and Gill,[2] in discussing the epidemiology of the disease in Alabama, state that reported cases have been ten times as common in the white race as in the colored race. They later add that the apparent high case fatality rate among Negroes in that state may to a considerable extent be due to less complete recognition and registration of cases for this group. Only in a large population in which all white and colored people are equally exposed and cases are accurately recorded could a definite decision be reached with regard to racial susceptibility to this disease.

The disease was more common among adults than among children and more common among males than among females. This is usually the case, since endemic typhus fever is in the main a disease occurring among employees in certain industries.

Clinical Manifestations—The clinical manifestations were in the main similar to those which have been previously described.[1-6] A rose to dark red, macular (in some instances maculopapular) rash was first seen in the majority of cases on the 5th or 6th day of the disease. The rash usually appeared first on the lower chest or upper abdomen. The erythematous lesions did not become definitely petechial or hemorrhagic except in 2 patients. It has been stated [4] from observations elsewhere that the rash becomes petechial in the severest cases. In Tennessee it appears that a petechial eruption is an exception rather than a rule. This point is of value in the differentiation of this disease from Rocky Mountain spotted fever.

In the colored patients no rash could be definitely observed, although in 4 cases lesions were present which were suggestive of a rash but could not be differentiated from natural blemishes. No rash could be observed in 2 of the white patients.

The average duration of fever in hospitalized cases was 15 days. The maximum duration was 40 days (including complications) and the minimum 9 days. Forty-five (60 per cent) of the patients were hospitalized.

Agglutination of Proteus X-19 organisms with the blood serum of patients was present in significant titers (1:160 or more) in 73 patients. Agglutination tests with the serum of 2 patients were not made, but the clinical

and epidemiological manifestations were such that there appeared to be no question as to the diagnosis.

Two cases resulted in death, giving a case fatality rate of 2.7 per cent. Each of these cases died of a complicating pneumonia. One of the patients who died was a white male, age 65, and the other a colored female, age 60.

THE CONTROL PROGRAM

In the latter part of October, 1939, when it became evident that Nashville was experiencing a severe outbreak of endemic typhus fever, the Health Officer of Nashville, through the Tennessee Commissioner of Public Health, requested the U. S. Public Health Service to assist in the institution of rat control measures in this city. One of the authors, a sanitarian of the U. S. Public Health Service, was detailed to Nashville for that purpose. Prior to this time a sanitarian of the City Health Department, who was given training in rat control by the Tennessee Department of Public Health in 1937, had given some assistance to local business concerns in rat control.

The epidemiological picture of these known focal areas gave sufficient evidence that rat control measures should be concentrated first in these areas, in order to destroy as many infected rats as possible, and to prevent the infection from spreading to other areas if it had not yet done so. The method employed was essentially that which had been developed in Georgia jointly by the State Department of Health and the U. S. Public Health Service.[7]

In order to prevent the driving of infected rats out into the surrounding area, the program was started several blocks in radius from the main foci of infection with the plan of working inward toward the center of each focal area. The heavy lines shown around each area in Figure 1 signify the location where work was started. A large warehouse or grain mill near the center of the area was selected as the final

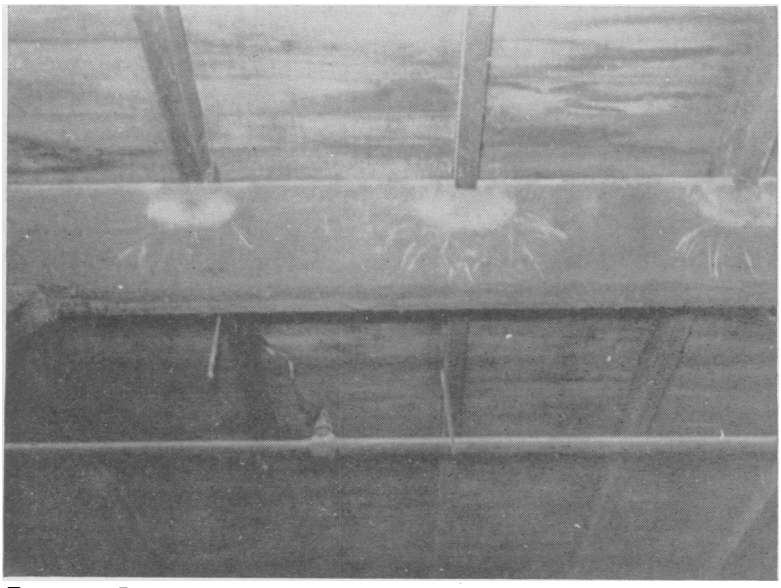

FIGURE 2—Rat run in a building whose floors and walls were covered with grain flour. Note white marks made by tails of rats.

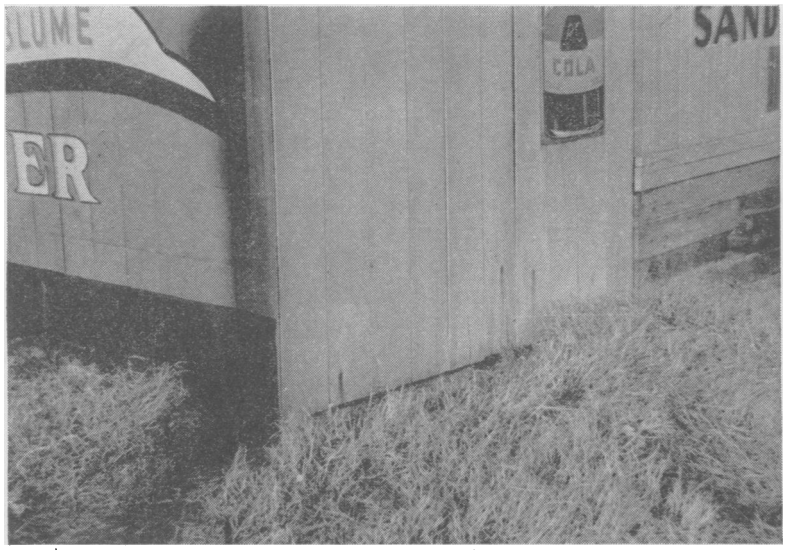

FIGURE 3—A wooden building close to the ground. Rat runs may be seen through the grass and under the building.

location for completing the work. Figure 2 shows visual evidence of rat runs in such a building.

Thirty men employed by the city as laborers were divided into three groups with two sanitarians of the City Health Department as supervisors of each group. The workers in group 1 were used to clean the area by removing garbage, refuse, and trash; those in group 2 were used in gassing, poisoning, and trapping; and those in group 3 were used in rat-proofing buildings. A U. S. Public Health Service truck built for mosquito control work, equipped with an air compressor and 500 feet of hose, was used to supply compressed air for gassing purposes. Gas hand-pumps were connected to the hose, and buildings and burrows were gassed.

Starting at the periphery of the area and working toward the center, garbage, refuse, and trash were removed and alleys, basements, outhouses, and yards cleaned. In order to prevent rat harborage, material worth salvaging was stacked 2 feet off the floors and ground. Rat burrows were gassed with cyanide A dust and the openings closed with earth. Poison bait and traps were repeatedly placed in sections cleaned until the entire area was covered. By this method a clean, presumably rat-free area was established between central portions of the area and the surrounding territory.

As foodhandling establishments were reached, a survey of the buildings was made to discover the places where rats could enter (Figure 3). The owners of these establishments furnished the materials and the laborers employed by the city did the rat-proofing. All ventilators and sidewalk gratings were closed with 16 gauge galvanized iron sheeting perforated with ½ inch holes. All outside doors were flashed at the bottom with 24 gauge galvanized iron sheeting which was extended up on the corners of the doors and on the facings for a distance of 10 inches so that rats could not gnaw at the exposed edges. Holes found around plumbing and cables and other breaks in brick or stone construction were closed with scrap brick and mortar. A wall of corrugated galvanized iron

FIGURE 4—Another view of the building in FIGURE 3. A trench 2 feet deep has been dug around the building and a wall of galvanized iron roofing installed 2 feet below the ground level and several inches above. The top edge has been firmly nailed to the building.

(metal roofing) was installed in a trench to a depth of 2 feet around wooden buildings and extended several inches up the side with the top edges of the metal firmly nailed to the buildings. The average cost of material for rat-proofing a building was $7.56, with a maximum cost for any one building of $47.70 and a minimum cost of $2.00.

After the building had been made rat-proof from without, the basement was gassed with cyanide A dust and the remainder of the building with cyanide G fumigant. In order to make sure that all rats in the building were destroyed, poison bait and traps were placed in it for several weeks after gas had been used. Where rat-proofing was not done, buildings were first cleaned of refuse and trash, materials were stacked to prevent harborage, and then poisoning and trapping were carried on until it was evident that no rats remained.

Trapping was done exclusively with steel snap-traps, since these traps usually snare the rat without killing it. By use of this trap, fleas which do not usually leave live rats are prevented from migrating, and can be destroyed with the rat. The trigger of each trap was brushed with a small amount of anise oil which, besides destroying the human odor, attracted the rats. The traps were set with the jaws parallel to the runs, which usually were found along the walls of buildings, fences, etc. Rats caught in the traps were killed, placed in flea-proof bags, and incinerated in order that fleas present on them would be destroyed.

The bait was mixed in proportions of 1 part red squill, 2 parts cereal, and 8 parts meat. Oatmeal or cornmeal was used as the cereal constituent, and cheap ground beef or canned salmon as the meat portion. Each individual bait, averaging about 1/3 ounce, was placed in the center of 1/4 of a cheap paper napkin which was then folded and twisted over the bait so that it was similar in appearance to a toy torpedo. At the time the baits were distributed, a cloth saturated with anise oil was tied

to the container in which the baits were carried. The baiter ran his fingers over this cloth before picking up the bait and placing it in the location desired. Fish bait was used in localities where cereal and grain had been freely accessible to rats, and beef bait was used where fish and poultry had been freely accessible to them. The poisoned bait was prepared at a cost of approximately 12 cents per lb. or ¼ cent per bait.

During the period November 9, 1939, to February 1, 1940, 3,268 rats were recovered and about 14,000 were believed to have been killed by poisoned bait. Of the rats recovered, 90 per cent were *Rattus norvegicus*, 8 per cent *Rattus alexandrinus*, and 2 per cent *Rattus rattus*.

POSSIBLE SPREAD FROM NASHVILLE

Among other cases of endemic typhus fever reported during 1939, 12 cases were reported in the small City of Lebanon, 30 miles east of Nashville on the Tennessee Central Railroad and also on a main arterial highway. This railroad has freight yards in Area 2 in the City of Nashville. These cases in all probability represent an extension of the infection from Nashville. During the autumn of 1939, 3 cases were reported from the City of Jackson, 142 miles west, and 3 from the City of Chattanooga, 138 miles southeast of Nashville. The cases in Jackson probably represent an extension of the infection either from Nashville or from Alabama, while those in Chattanooga probably represent a spread from Georgia.

DISCUSSION

The control measures instituted in Nashville were emergency measures aimed at preventing the spread of the infection to other parts of and outside the city. It is probable that infected rats had already moved beyond the known focal areas. The extension of rat control and rat-proofing to all parts of the city is indicated and is being planned.

The method of rat-proofing which has been briefly described in this report is only intended to prevent the entrance of rats into buildings. It requires constant maintenance in conjunction with poisoning and trapping of any rats which gain entrance. Such a program of rat-proofing is recommended for use in buildings already constructed, the procedure being attractive to merchants because of the low cost involved. On the other hand, complete and permanent rat-proofing of buildings already constructed, including the elimination of all rat entrances and all possible nesting places within the building, is not attractive because of its high cost.

The passage and the enforcement of a rat-proofing ordinance by city governments generally are advisable. Such an ordinance should require the rat-proofing of all buildings to be constructed, repaired, or remodeled, and should require maintenance after construction. A model ordinance has been prepared by the U. S. Public Health Service[8] covering all essential points. An ordinance has been drawn, based on this model ordinance, which is to be submitted to the City Council of Nashville for consideration. The proper collection and disposal of garbage, removal of litter, abolishment of dump heaps, insanitary privies and cesspools, and establishment of general cleanliness, including even the periodic cutting of weeds in open lots, also play an important part in rat control.

It is evident that endemic typhus fever is spreading into the interior of the United States from the original foci of infection on the south Atlantic and Gulf coasts. The infection already has spread as far north as Tennessee, the first known focus in this state being

found in Nashville in 1935. Meleney [9] has outlined the extent of the disease in the southern United States as of 1939. State and local health officials in general, and those of the southern states in particular, must seriously consider active programs of rat control and rat-proofing in all villages, towns, and cities. The institution of this program should not be delayed until after foci of the disease have been established but should be started immediately. Specially trained personnel are essential if a program is to be successful. Such a program will not only control but will also provide a barrier against endemic typhus fever and other rat-borne diseases such as bubonic plague, and will more than pay for itself by decreasing the great economic loss due to rats.

SUMMARY

1. The first case of typhus fever to be officially reported in Tennessee occurred in 1926. By January 1, 1940, 168 cases had been reported.

2. The first known cases of typhus fever in Nashville were reported in 1935. A focus probably was established first in the southern part of the city in a feed mill located on two railroads a short distance from where they enter the city. By January 1, 1939, 31 cases had been reported.

3. An outbreak * occurred in Nashville in 1939. Seventy-five cases were reported, of which 60 were among white persons and 15 among colored. The case fatality rate was 2.7 per cent.

4. One or the other of three foci in the city was determined as the probable source of infection for 70 cases.

5. Trapping, poisoning, removal of garbage and trash, and rat-proofing were done in each area, starting several blocks in radius from each focus and working inward toward the midpoint.

6. Foci of the disease have been established in three other cities in the state, representing a spread either from Nashville or an extension of the infection from Alabama and Georgia.

7. Since the disease is spreading inland from the original foci in the southeastern states, state and local health officials in general, and those of the southern states in particular, must consider seriously active programs of rat control.

REFERENCES

1. Dyer, R. E. Diseases of the Typhus Group in North America. *Canad. Pub. Health J.*, 28:1–9 (Jan.), 1937.

2. Baker, J. N., McAlpine, J. G., and Gill, D. G. Endemic Typhus in Alabama. *Pub. Health Rep.*, 50:12–21 (Jan.), 1935.

3. Rumreich, A., Dyer, R. E., and Badger, L. F. The Typhus-Rocky Mountain Spotted Fever Group. *Pub. Health Rep.*, 46:470–480 (Feb.), 1931.

4. Maxcy, K. F. Clinical Observations of Endemic Typhus (Brill's disease) in Southern United States. *Pub. Health Rep.*, 41:1213–1220 (June), 1926.

5. Lumsden, L. L., and Tucker, C. B. Clinical and Epidemiological Features and Differential Diagnosis of Rocky Mountain Spotted Fever and Endemic (murine) Typhus Fever. *J. Tennessee M. A.*, 32: 339–341 (Oct.), 1939.

6. Virus and Rickettsial Diseases. *Harvard School of Public Health Symposium Volume*, Harvard University Press, 1940.

7. Boston, R. J. Public Health Engineering Phases of Murine Typhus Control. *A.J.P.H.*, 30:619–626 (June), 1940.

8. Holsendorf, B. E., and Clark, P. W. The Rat and Rat-proof Construction of Buildings. *Pub. Health Rep.*, Supp. No. 131, 1937.

9. Meleney, H. E. The Recent Extension of Endemic Typhus Fever in the Southern United States. *A.J.P.H.*, 31:219–227 (Mar.), 1941.

* Since this report was prepared early in 1940, it is interesting to note the subsequent incidence of typhus fever in the city. Eighteen cases were reported during the year. During the first two months of 1940 and prior to the time control measures had been completed in Area 2, 3 cases occurred among employees of a freight depot in that area. During the summer and autumn of 1940, 4 cases were reported from the immediate section around Area 1, and 7 cases from the immediate territory around Area 2. Four cases were reported among employees of a dog food factory located about seven blocks from the center of Area 2. This represents a new focus of infection. In addition, 4 cases in residents of Davidson County may have obtained the infection within the immediate vicinity of Area 2. The location of probable sources of infection in 1940 indicates that it will be necessary to extend the control measures over a large area if the disease is to be held under control in Nashville.