

Public Health Engineering Phases of Murine Typhus Control*

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IN the light of our present-day knowledge of murine typhus fever—a disease primarily of rats and secondarily of man—control measures are aimed, directly or indirectly, toward rat destruction. Murine typhus fever, as it occurs in Southeastern United States and particularly in Georgia, is comparatively new, and its recognition as a communicable disease subject to control by engineering practices is recent. As a matter of fact, suspicion of the rat as a possible reservoir of murine typhus fever dates back only about 13 years.

It is the purpose of the writer to confine this paper, in so far as is practicable, to a discussion of the public health engineering phases of the control of this disease. No attempt is made here to outline a standard procedure for typhus control or to suggest that the methods currently employed by the Typhus Control Unit of Georgia may be equally applicable in other states. Rather, it is hoped that this discussion of the Typhus Control Program in Georgia may prove of some value to public health engineers who are or will be assigned to a similar problem.

ORGANIZATION OF TYPHUS CONTROL UNIT

Due to the rapid increase of typhus fever in Georgia, from 51 cases and 1 death reported in 1929, to 1,092 cases and 54 deaths reported in 1937, the Georgia Department of Public Health established a Typhus Control Unit within the Division of Sanitary Engineering in 1937. The purpose of this unit was to formulate plans for a state-wide program of controlling this disease, whereby advisory assistance could be rendered to county and municipal governments, as well as to organize local control programs. This state-wide unit, headed by a public health engineer, includes an assistant engineer and a clerk. In February, 1938, the Division of Epidemiology assigned an assistant epidemiologist to work in coöperation with the Typhus Control Unit, making investigations of reported cases in certain counties of the state.

THE TYPHUS PROBLEM IN GEORGIA

During 2 years' operation of the Typhus Control Unit, in coöperation with the Division of Epidemiology, studies have been made from field investigations, examinations of morbidity and mortality reports, and spot maps showing the distribution of the disease throughout the state. These studies have brought out certain general fac-

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tors important in organizing an effective control program in Georgia. The most important are the following:

1. Spot maps indicate that the disease was originally introduced through seaport towns and spread inland by means of main lines of communication. We find that about 93 per cent of the reported cases during 1937 occurred in the southern half of the state, the greatest incidence being in about 25 counties of Southwest Georgia.

2. Special studies by the Division of Epidemiology have indicated that the disease is principally an urban one, although there are some few counties in which the disease has been reported throughout the farming area.

3. Most of the urban cases have been traced to individuals employed in, or closely associated with food handling establishments, such as restaurants, grocery stores, markets, warehouses, etc. In many instances more than one case has been traced to a single business establishment. In these places a high rat infestation is usually found, due no doubt to the abundance of available food supply and harborage.

4. Although the disease occurs throughout the year, the greatest number of cases is reported during July, August, and September, with the lowest number during February and March. This variation may be correlated with the high rat flea index during the warmer months and the low rat flea index during the colder months.

5. The Norway or brown rat, *Rattus norvegicus*, the predominant species found in this state, is probably the principal reservoir of typhus infection. Other species of rats encountered are the *Rattus rattus rattus* or black rat, and the *Rattus rattus alexandrinus* or roof rat. In addition, in Southwest Georgia there has been found a black rat with all the characteristics of the Norway rat except color; also specimens of what is apparently a cross between a white rat and a black Norway rat, which has all the characteristics of the Norway with the exception of the coloring. A cross between black and brown of the Norway species has been noted.

6. The Norway rat is generally found in large numbers in those areas where typhus is prevalent. Studies made in 1934 by the Division of Epidemiology in two large cities of the state in which typhus was prevalent revealed that more than 90 per cent of the rats trapped there were of the Norway species; whereas in a coastal city in which typhus apparently did not exist, only about 43 per cent of the rats trapped were Norways, the remaining 57 per cent being *Rattus rattus*

rattus and *Rattus rattus alexandrinus*. It has been observed in general that where there is a large Norway rat population, there is a correspondingly low population of the other two species, thus making it apparent that the *Rattus rattus rattus* and *Rattus rattus alexandrinus* flee before the invasion of the vicious Norway.

7. The two most common species of rat fleas found in Georgia are the *Xenopsylla cheopis* and the *Nosopsyllus fasciatus*, both of which are commonly known to be carriers of the virus of typhus fever. Flea indices from rats trapped in the business districts of towns are higher than those from rats taken at residences.

THE CONTROL PROGRAM

The control program was planned and organized with these factors in mind; and control measures, based on educational work sponsored by the state and local health authorities, are conducted on a voluntary plan of local participation. In other words, the State Typhus Control Unit serves in an advisory capacity in making preliminary investigations of the local problems, recommending control measures, and training local personnel in counties and towns. Costs of local supervisory services and all labor and material are defrayed by municipal governmental agencies or by individuals.

It has been our experience that the interest in typhus control in towns or counties is usually created through one of two ways. Frequently, this comes about as a result of a local outbreak of typhus fever involving some of the leading citizens, or through the state-wide educational program sponsored by the Typhus Control Unit of the State Health Department. Too often, however, the interest among citizens is created by the former case. It is also true that interest in rat control is sometimes brought about strictly through the economic benefits that may be derived. As a result of this interest, a request for assistance from local governmental agencies or county health departments is usually transmitted through the

medium of official correspondence to the State Health Department which in turn is referred to the Typhus Control Unit.

PRELIMINARY INVESTIGATIONS

Before any control work is actually inaugurated, certain investigations are essential in order that the proper control measures may be applied to give the most effective results. These are epidemiological and engineering in character.

Epidemiological investigations precede the engineering investigations and indicate the possible foci of the disease on spot maps.

Engineering investigations of the indicated foci partly substantiate epidemiological investigations. Engineering investigations are directed toward the determination of the prevalence by species of rats encountered; types of buildings and amount of harborage; and garbage conditions and harborage on premises. The nature of the businesses, such as grocery stores, drug-stores, hardware stores, warehouses, etc., located in the foci must be considered.

Determination of the economic status of individuals and of the town as a whole must be ascertained because of its importance with relation to the type of program that may be recommended.

REPORTS AND RECOMMENDATIONS

Reports based on the findings of the preliminary investigations are submitted to the responsible authorities, the purpose being to describe the extent and nature of the typhus problem in relation to the existing rat infestation, and to outline the methods of its control. These reports include cost estimates covering the recommended control measures. They are important in that they convey to the responsible authorities the fact that serious study has been given to their problem and that the

points where control measures should be inaugurated have been located.

The general control measures recommended, based on the findings of the investigations, include one or more of the following: rat extermination, garbage control and clean-up, and rat proofing. These three control measures, either singly or together, have been employed in Georgia with considerable success since the establishment of the Typhus Control Unit.

CONTROL MEASURES

We consider an educational program of basic importance to the success of any typhus control program. The general educational program under the direction of the Typhus Control Unit is conducted on a state-wide basis through the following media: newspaper articles; lectures before school, civic and professional groups; pamphlets and bulletins; radio talks; demonstrations and exhibits.

More intensified local education is conducted along lines similar to the state-wide program. Meetings are held with special groups of citizens who are directly affected by the typhus problem. A plan of visual education is employed. Slides are shown to illustrate conditions favorable to rat life and the various control measures currently used. Handbills and leaflets on typhus are inserted in the water bills to arouse local interest.

EXTERMINATION

Rat extermination by means of poisoning and trapping can be relied upon only as a temporary means of typhus control. General rat extermination campaigns are spectacular only in producing remarkable results in the number of rats killed in a short period of time.

In Georgia, rat extermination by means of poison bait is confined chiefly to those areas determined by epidemiological investigations to be active foci. In such sections it is used to relieve

immediate emergencies created by outbreaks of typhus fever. These sections may consist of the entire business district of a small community or specific business blocks of a large city. To control typhus by this means, it must be repeated every two or three months or until permanent control measures are established. Its use other than in focal points is to reduce the rat population in existing buildings in which rat proofing has been partially installed.

There are a number of effective commercial poisons on the market. Only one—red squill—is extremely toxic to rats, yet harmless to human beings and pet animals. For this reason, it is the only poison used in the Typhus Control Program in Georgia at the present time.

In order that the bait will be properly placed, the workmen in charge of distributing bait are trained by the typhus control engineers prior to the actual start of the program.

The mixture of this bait depends entirely upon the toxicity of the squill used. Red squill with a toxicity of 3 to 4 grains per pound of rat is mixed in the following proportions: 1 part of squill, 3 parts of cornmeal, and 12 parts of meat or fish. The mentioned ratio refers to weight. It is advisable to distribute two kinds of bait and we have found that meat and fish are the most desirable.

Bait prepared in the form of torpedoes renders the most effective results. Torpedoes are made by placing about $\frac{1}{2}$ teaspoonful of bait (which weighs about $\frac{1}{2}$ oz.) in paper napkins and twisting the ends. Colored napkins are used to differentiate between the kinds of bait used. The effectiveness of torpedoes lies in the fact that they are small enough to be carried into rat harborages, resulting perhaps in the destruction of an entire nest.

During the past 2 years the Typhus Control Unit in Georgia has supervised 23 rat extermination campaigns with

distribution of approximately 14,470 lbs. of bait, employing red squill as the killing agent. On this basis we have determined certain information to be used in estimating the cost of campaigns. For a town with a population of less than 10,000, the amount of prepared bait required, based on the total population of the town, is 0.05 lb. per person for the business district; while for city-wide extermination, the amount of bait needed is 0.25 lb. per person. For one business house an average of 1.75 lbs. is used and for a residence an average of 0.75 lb. is usually sufficient. Approximately 0.5 lb. per person is required for farming areas, or about 2.5 lbs. for each farmhouse. These figures are estimates only, yet they are found to be accurate enough for estimating campaigns in our state. The bait actually used depends, in the last analysis, upon the amount of rat infestation, type of building, and the thoroughness of the workmen in distributing the bait.

Usually $\frac{1}{2}$ man-hour is required for mixing and distributing 1 lb. of bait in either business district or city-wide programs.

Estimates for large cities must be determined by existing conditions in the areas that are to be treated.

Trapping is a very expensive control measure consuming a large amount of time in proportion to the results obtained, as compared with poisoning. It does, however, have an important place in typhus control in regard to rat and ecto-parasite surveys. Trapping is employed as a means of reducing the rat population in existing buildings to which partial rat proofing has been applied. The two principal traps used are the steel trap which requires no bait, and the wooden or guillotine trap which requires bait. It has been our experience that best results are obtained from the former.

Poisonous gases as a means of fumigation of buildings are not used by the

typhus control engineers. Fumigation should be under the direct supervision of experienced workmen in order not to jeopardize human lives.

GARBAGE CONTROL AND CLEAN-UP

Generally speaking, garbage control and clean-up of premises is not considered directly as an important hygienic problem. However, when applied to typhus control this problem is of major importance.

Exposed garbage consisting of vegetable substances and house and kitchen offal often serves as the bulk of the rats' food supply. To remedy this condition garbage containers are not only necessary on all premises, but they should be used at all times. These recommended containers should be water-tight and constructed of heavy galvanized metal. A tight fitting top, easy for the user to remove, should be kept on the container at all times. The container or containers should be of sufficient volume to hold or protect the garbage accumulated between collections. They should be installed in such a manner that they cannot be overturned by dogs or other animals.

Clean-up of premises as applied to this program is the removal or proper storage of old lumber, boxes, rubbish heaps, trunks, piles of brick, etc., that offer the possibility of hiding and nest-

ing places for rats. It also refers to low wooden floors and other enclosed spaces that are found in garages, chicken coops, and other outbuildings.

To promote the proper handling of garbage and the clean-up of premises, we have recommended garbage ordinances, municipal sanitary inspection services, and necessary improvements in the collection and disposal of garbage.

The proper control of these conditions results in the shifting and decrease of the rat population in a community. Incidentally, rat poisoning campaigns are more effective following a thorough garbage control and clean-up campaign.

RAT PROOFING

Rat proofing is essentially the separation of man and rat. It is only through rat proofing that permanent control of typhus fever may be accomplished. All other measures are considered temporary or secondary.

No attempt will be made here to outline in detail the principles involved in rat proof construction of buildings. This measure as the major part of the typhus control program in Georgia will be discussed principally in regard to existing buildings.

Existing buildings, which are the main source of rat infestation at the present time, are of more importance than new buildings in relation to the immediate control of typhus fever. Rat harborages are usually found beneath low wooden floors, between floors and ceilings, in double walls, in enclosed stairways, in various types of fixtures and equipment, and in mass storage of merchandise.

To encourage merchants to rat proof their buildings, we find that the corrections for each building must be presented in a practical manner. These recommendations are submitted to each individual in the form of a written survey which outlines in detail defects and corrections to be applied.

By utilizing this method of approach

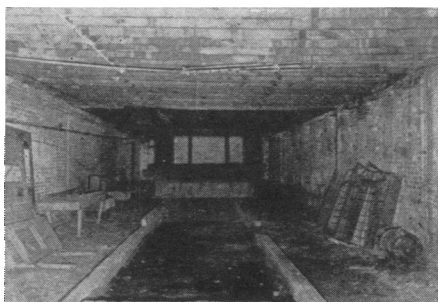


FIGURE 1—Rat proofing of cellar. Low wooden floor removed. Abandoned store fixtures in center and elevated above earth floor.

to the individual merchant, approximately 250 rat proofing jobs have been completed. Although recommendations for the complete elimination or protection of all existing rat harborage have not been complied with in full, sufficient work has been done to render the buildings rat free, which is the prime purpose of the survey. It has been the general impression of the average merchant approached that rat proofing entails expensive outlay. So far in Georgia, however, the maximum cost for labor and material utilized in this work has been \$100 per building. The minimum cost has been about \$15, with the average approximately \$25.

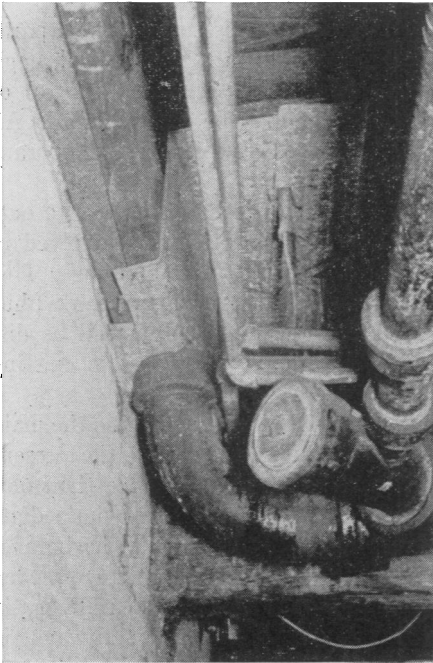


FIGURE 2—Rat proofing as applied to pipes. Galvanized metal installed around pipes to prevent rats from gaining entrance to upper floors.

The rat proofing discussed so far has applied only to individual business houses with the tenant or owner bearing all costs of the work.

Rat proofing of individual buildings is a long-term program requiring many

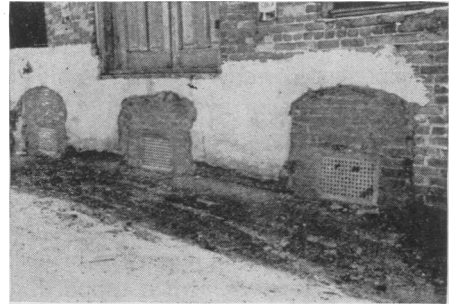


FIGURE 3—Vent stoppage. Former ventilator openings in exterior wall closed with brick, perforated galvanized metal and cement.

years to show any appreciable reduction in the prevalence of typhus fever. In view of this, it has been necessary to find a method of control that would be city-wide in scope, relatively inexpensive, and effective as a typhus control measure. With this in mind, we have adopted a vent stoppage program.

Vent stoppage is basically a part of rat proofing. It may be defined as the closing of all openings in the exterior walls of buildings to prevent the ingress and egress of rats. As the name implies, it is the protection of all sidewalk and wall ventilators, using 16 gauge galvanized sheet metal plates perforated with $\frac{1}{2}$ " holes. It also includes the flashing of doors, especially rear doors, with 24 gauge galvanized sheet metal. In addition, other openings in exterior walls are closed with material that is impervious to rat gnawing. This program is financed by the municipalities

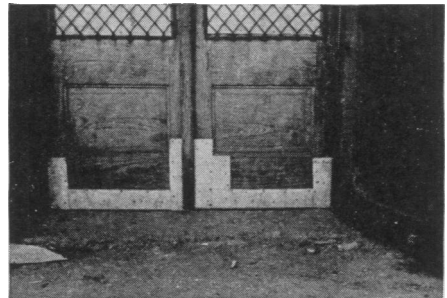
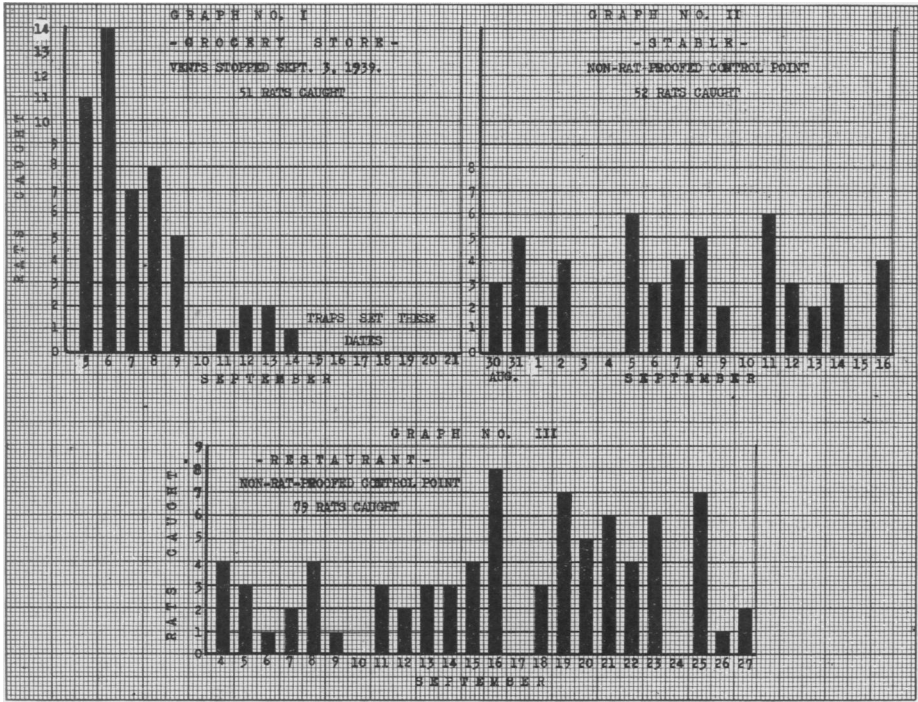


FIGURE 4—Vent stoppage. Rear door to business establishment protected with galvanized sheet metal.



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rather than the individual merchants. To date, vent stoppage work has been completed in 2 municipalities, and at the present time it is in progress in 4 others. A total of 225 buildings have been protected in this manner. The average cost to the municipality has been less than \$5 per business house.

Work of this nature has been in progress for only about 4 months in Georgia. Thus, it is too early to attempt at this time to place any definite evaluation on the program; however, a reduction in rat life has been observed in the business districts of the two communities in which this work has been completed. Graphs I, II, and III are submitted to show trapping results in control points of one municipality.

New buildings rat proofed since the establishment of the Typhus Control Unit have been accomplished through personal conferences with owners, architects and contractors. Rat proofing ordinances have been enacted in several

municipalities as a result of the public interest created by the typhus control program.

SUMMARY AND CONCLUSION

Due to the increasing incidence and the nature of the problem of murine typhus fever in Georgia, a Typhus Control Unit, under the direction of a public health engineer, was established in 1937. As a result of preliminary studies of the state-wide problem, the control program adopted and currently employed consists of preliminary investigations and control measures employing the use of rat extermination, garbage control and clean-up, and rat proofing. Only the essential features and the value of each control measure have been attempted in this discussion.

From our experience with this disease, we conclude that:

1. The control of murine typhus fever is basically a public health engineering problem.
2. Epidemiological and engineering investi-

gations are necessary for the success of the control program.

3. A well organized educational program is indispensable.

4. The use of toxic red squill bait in the form of torpedoes is an effective means of temporarily reducing the rat population, and consequently, typhus fever when applied in

areas predetermined to be foci of infection.

5. Garbage control and clean-up affords an effective means of reducing the rat population on premises through starvation and destruction of harborages.

6. Rat proofing is the only permanent means of rat control and murine typhus fever control.