Rat Surveys and Rat Proofing

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ACCORDING to data obtained from almost world-wide sources, and published in many of the pamphlets issued by the U. S. Public Health Service and other government agencies, including bulletins issued by the U. S. Department of Agriculture, the rat is not only the least useful, but is perhaps one of the most dangerous and expensive of nature's parasitic animals living at the expense of man. Of all disease-bearing animals, the rat probably stands supreme in the cost it has entailed upon mankind in lives and money.

It is estimated that in any given community, the rat population equals that of the human inhabitants. They are very prolific, producing on an average of 5 litters a year, of from 6 to 9 each. The cost of feeding a rat is placed at ½ cent per day, or almost $2 per year. Assuming that the estimated rat population in the United States is equal to the number of persons shown by our last census, the cost of feeding rats will reach the staggering sum of $240,000,000 annually. In addition, they pollute and render unfit for consumption quantities of supplies many times in excess of what they eat, and destroy all kinds of articles and merchandise.

Since such economic losses and sanitary risks are shared by almost everyone the world over, whether or not this fact is known and appreciated, the hand of man, in all lands, has been raised against the rat. Almost every known means has been employed to reduce their numbers, or to exterminate them. Usually the interest of the average citizen in this matter becomes aroused only when it is brought to his own door, and either he or his family are annoyed by their presence, or they sustain economic loss. It expresses itself in the periodic drives, trapping and poisoning campaigns which are carried out from time to time.

From what is known of the breeding habits of rats, their fecundity, their resourcefulness, their adaptability to almost any condition, and their ability to subsist on any kind of diet (their bill of fare includes almost anything in the vegetable and animal kingdom), the magnitude of the task of rodent control can be better appreciated. The problem is one of grave public concern and can be solved in whole or in part only by continued and persistent effort in carrying out measures that are known to produce effective, permanent results, so that freedom from rat life will be the normal state. It is the maintenance of this condition rather than the periodic reduction of the rat population that will confer the highest degree of protection to the public health, as well as lessen economic losses.

The problem of control is three-sided. It concerns health, economics, and technic.

The public health official, whether national, state, or municipal, is interested in permanent control because it aids in reducing the risk of the trans-

mission of certain diseases, principally bubonic plague and typhus fever. Prevention of the spread of these diseases is his main objective.

On the other hand, owners of property and merchandise are interested primarily in reducing the destruction of supplies of almost every kind by rats. Prevention of economic loss is their objective.

The solution depends largely on the application of technical methods and the use of common sense. As one authority says: "The permanent exclusion of rats involves primarily the proper construction, repair, and upkeep of buildings, and keeping the premises in a sanitary condition."

Rat life exists and persists in buildings and elsewhere because of certain favorable structural and incidental conditions, which enable them to hide, build their nests, and breed. If these conditions are changed, either through the employment of a different design, construction methods, or materials impervious to gnawing by rats, or altered by repair work so that the harborages are either eliminated or protected in such a manner that rats cannot get into them and build nests, and breed, colony rat life will be permanently controlled.

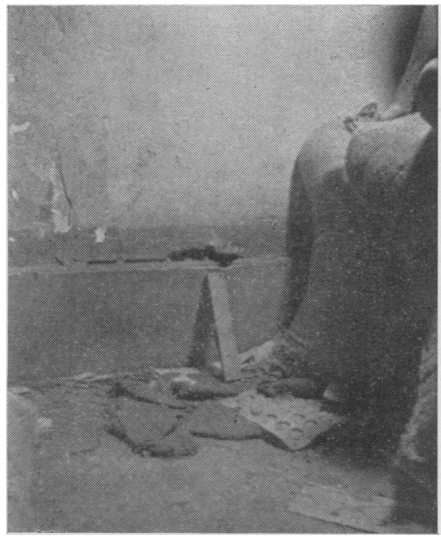

FIGURE I—Example of structural rat harborage existing in the enclosed spaces formed by double walls and raised flooring

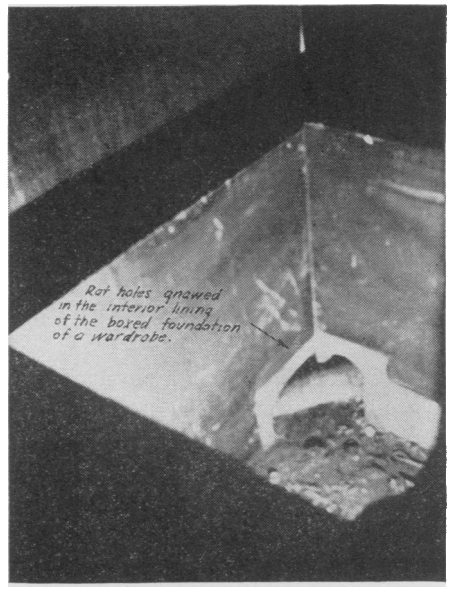

FIGURE II—Example of incidental rat harborage existing in the boxed foundation of a wardrobe. Note rat excreta and nesting material on floor and large rat hole in the back corner. Several nests containing baby rats were found in this space.

The first step, therefore, is to become thoroughly acquainted with the conditions which favor rat life (that are known as harborages), to be able to recognize them and to appreciate the effect which their existence has on rodent propagation.

There are 3 general types of rat harborages: (1) structural, (2) incidental, and (3) temporary. Examples of the first are double walls, spaces between floors and ceilings, and beneath basement floors, or those that rest flat on the surface of the ground.

Those of the second are furniture, fixtures, and equipment, things that are incidental to the use that is made of

the building or its subdivisions, and are installed therein.

Examples of temporary harborage are mass storage of material or merchandise, rubbish heaps, old furniture, odds and ends piled in cellars, attics, closets, etc. Any such material if left undisturbed for periods of several weeks can and will be used for homes and breeding places by rats.

The preliminary work in any campaign of rat control is that of survey. The conditions existing in each district and subdivision must be known; therefore, inspectors should become conversant with the various types of harborages, be trained to recognize them and to evaluate their relation to rat propagation. They should learn how to look for signs of actual rat infestation of premises, such as fresh excreta, rat gnawings, marks of rat runs, or damaged merchandise and supplies. The physical state of the excreta found will usually tell whether the infestation is of recent origin. If the excreta is of putty-like consistence and can be rolled out like a pill mass, it is more than likely that live rats are present. The quantity of excreta found will aid in determining the extent of the infestation.

The port sanitary authorities at Liverpool, England, some years ago carried on a number of very interesting experiments in order to determine the quality and quantity of excreta passed during a given time by captive rats. Each rat used in the test was confined in a separate cage which had a removable bottom pan. One group was fed on grain products, another on fruits and vegetables, while a third was given only meats and fish. The rats fed on grain products passed the greatest amount of excreta, averaging about from 70 to 75 pieces per 24 hours, while the group fed on fruits and vegetables averaged less than 50 pieces for 24 hours.

Knowledge of this character is of value to an inspector or surveyor and aids him in forming an intelligent estimate of the extent of the infestation.

The size of the various pieces of excreta discovered will determine whether family life is present and litters of young are being reared.

It will thus be seen that it is possible in survey work to learn 3 valuable

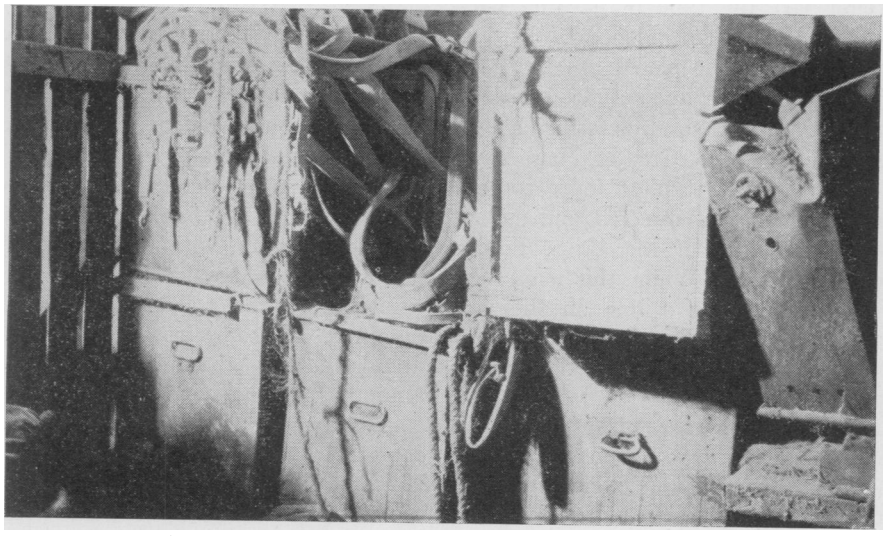

FIGURE III—Example of rat harborage of the temporary type existing in discarded material usually stored in attics and cellars

things through the examination of excreta found: (1) Whether the infestation is an old one or of recent origin; (2) from the quantity and location, the probable extent of the infestation; (3) from the various sizes of excreta, whether families of rats are being reared.

It is not so easy to differentiate between an old and recent rat run. By washing off a small area of a well defined run or by covering it with paint or white chalk, it will be easy to check up on any section where doubt exists as to present infestation. The rat is such a creature of habit that he will continue to run over the beam or pipe where the original run was located.

Recent gnawing into wooden base boards and sheathing around pipes and other lines can easily be determined by its fresh appearance and the presence of shavings or débris. The same will be found to be true to a great extent of gnawings into and damage to merchandise and food supplies.

Properly conducted surveys of buildings and structures will disclose the following facts: (a) the absence or presence of actual infestation and its extent; (b) the type of existing harborage and the coincidence of its use by rats as breeding places.

During 1934 and 1935 surveys similar to what has been described above were conducted in Greater New York as a part of the typhus fever control project which was directed and supervised by officers of the U. S. Public Health Service. While the main objective was to get a line on the flea index of the rats living in the various districts of Greater New York, advantage was taken of the opportunity to get data relating to rat infestation and the existence of rat harborage in the buildings surveyed and trapped. Some interesting facts were revealed as to both.

The principal types of harborage discovered coincided with those found by other investigators in similar surveys: double walls, space under floors, the enclosed space formed by sheathing in the ceilings, in cellars, bins and lockers, particularly when they had a raised floor, the interstices between the stones of foundations, burrows formed in dirt floors and cellars, in insulated sections of refrigerators, in mass heaps of supplies and rubbish.

The points of entry into the enclosed spaces which formed harborages, where the rat either found an opening or made one for himself by gnawing, were noted and, in many instances, were photographed. Information of this character is all important. No corrective measures can be successfully applied until the weak or vulnerable spots and the factors that make them so are known and taken into consideration. They may be the result of poor design, faulty construction, use of non-rat-proof material, or the manner in which fixtures, etc., have been installed.

If of design, the permanent correction must be brought about by changes which should be made in drafting rooms. If the result of the use of materials that can be gnawed by rats, the remedy will be found in the selection of those that have been proved to be rat proof. Non-rat-proof material can be protected at gnawing margins by metal flashing.

Some tests of materials have been made by the U. S. Public Health Service in connection with its work of the rat proofing of vessels. It was rather a surprise to note some of the results obtained. In some instances rats were able to gnaw through medium soft aluminum sheets. Lead sheets, of course, are not rat proof and openings into them are easily made.

In conducting these tests, the colony of wild rats were isolated in a rat proof room. They were given living conditions similar to those found on ships

and in houses, the use of double walls, lockers, etc. and fed regularly. In most instances they were undisturbed for several months and allowed to bring up families. When it was desired to test a certain material, it was made fast to the end of the test box, which was entirely covered with wire mesh except on one side. Food was stored in this test box, the open end closed with a strip or sheet of the material to be tested, and placed in the rat proof room. For a week previous no food had been given to the rats living in the room so that they would feel very strongly the hunger instinct, and be immediately attracted to the test box with its visible food contents. Usually the rats would surround the box and try to find an opening which would permit them to enter and get at the food. They soon realized that the heavy wire mesh effectively barred their entry and that their only chance was in gnawing along the edges of the sheet material and making a hole big enough to enter. If they were successful, even though it took several days, the material would be considered not rat proof, and its employment in construction discouraged.

Construction and installation methods —There are many instances of heavy infestation of buildings ashore as well as ships afloat that have resulted from failure to observe one of the fundamental rules of rat proofing, *i.e.*, that there should be no openings greater that ½" in any double wall sheathing. Carelessness of workmen in not making tight fits or closing openings through which pipes, beams, electric cables, etc., pass, are responsible for many opportunities given to rats to gain access to harborage.

The general rule to be applied in the rat proofing of buildings, so far as the exterior is concerned, is to make them secure from invasion by protecting all known avenues of ingress, in the foundations, outer walls, doors, windows, various pipe and cable supply lines, down spouts, light and air shafts, and other roof openings. This gives what is known as the outer line of protection. It can be seen how important it is to know that the material which has been employed is of an anti-gnawing or rat proof character, that this has been installed in an approved manner, and that it is being maintained in good repair.

Absolute reliance should not be placed on the protection afforded by the rat proofing of the exterior of buildings since there are always natural openings, such as doors and windows, to be considered. It is here that the human element enters into the equation, and this is always the weakest link in the chain of protection. Time and time again it has been found that it cannot be depended upon. Rats come into the buildings through the doors and windows and proceed to avail themselves of the facilities offered in double walls, beneath floors, etc., for home making. We have records of a school building that was invaded by rats through a window in the basement, and quite a colony were living in boxed settees, pipe tunnels, etc.

Exterior rat proofing of small buildings can be accomplished by elevating the structure 2 or more feet from the ground, exposing the ground area beneath and keeping it clean and free from trash, dunnage and rubbish. The usual protection should be given to the natural and other openings. If the building is of double wall construction, they should be shut off by stopping the openings left between the studs and floor joists just above the sill. Various classes of material are employed for these fills, such as 2" x 4" wooden beams, sheet metal, brick, and concrete.

Rat proofing work in the interiors of older buildings which are infested

may be accomplished in an inexpensive manner if the plan of treating symptoms as they appear is followed. That is, to install metal collars, metal flashing, or other protective and anti-gnawing material over openings and holes leading into enclosed spaces and double walls that are used as harborages, and to continue this until all such openings have been properly protected and rat life has disappeared.

Where a structure is built on footings or foundations, these should extend at least 2′ below the surface and be of concrete or stone which has been cement-plastered to a smooth finish. Rats invade cellars and basements by burrowing under walls that extend less than 2′ below the surface. Experiments were conducted by officers of the U. S. Public Health Service some years ago to check up on the habits and activities of rats, and standard rat proofing work was outlined largely on the basis of their findings. Hundreds of captive wild rats were used in these tests, which were to determine to what depth they would burrow, their swimming radius, their ability to climb the various types of pipes, downspouts, exterior wall surfaces, their homing instinct, etc.

In addition, the ordinary everyday life habits of several hundred captive wild rats living under conditions similar to those to which they were accustomed on shipboard were observed and studied at Hoffman Island for almost 2 years. They were confined in a rat proof basement room, and during these 2 years none escaped. Eskey says:

"Rat proofing of buildings and the elimination of harborage near them not only will prevent man from coming in close contact with rats, but also will eliminate the most productive breeding places of the *X cheopis* (fleas)."[1] The flea is the transmitting agent of typhus as well as plague.*

While the observations of this and other plague experts as to the value of rat proofing as a permanent rodent control measure coincides very generally with our own experience, we do not delude ourselves with the idea that perfection has been attained, and that by the waving of this magic wand all the rats in a community can be made to disappear as in the legendary case of the Pied Piper of Hamlin. Moreover, it is felt that because of the knowledge acquired through surveys and studies, we have been able to put into effect a campaign based on sound scientific principles and a fair knowledge of rat psychology and habits.

If the persons responsible for the planning of rat proof construction, its incorporation in buildings, and its upkeep, will be alert, resourceful, determined, and as tireless in their efforts to "build out" the rat as we have found him to prevent his species from becoming extinct, permanent success is assured.

REFERENCE

1. Eskey, C. R. An Epidemiological Study of Plague in the Hawaiian Islands. *Pub. Health Bull. No. 213.*

* ["It has thus became possible to state in a general way that the disease known as typhus has two main manifestations—the first and better known is *true typhus*, a louse-borne disease of great communicability from one person to another in times of overcrowding among an unclean population, and characterized by its tendency to the formation of epidemics; the second *(endemic typhus)*, a disease primarily of rodents which is transmitted from rat to man by rat fleas. This manifestation of typhus is, seemingly, not transmitted from man to man direct and is therefore characterized by its tendency to remain endemic." *Manson's Tropical Diseases*, 10th ed., edited by Philip H. Manson-Bahr, Baltimore: Wood, 1936, pp. 218–220.]