THE PREVENTION OF PLAGUE THROUGH THE SUPPRESSION OF RATS AND MICE.*

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(*Continued from p.* 98.)

Another bacillus which, like that of Löffler, is met with only in commerce was discovered, but very imperfectly described, by Danjsz† at the end of 1895, who isolated it from mice during an epizootic which spontaneously occurred in the laboratory, and named it the *Coccobacillus murium*. It is short and thick, but presents various and dissimilar forms. It develops quickly and regularly at a temperature of 18° to 20° C. On gelatine, and also on agar, it gives round colonies which, when they develop together, assume a dirty gray colour with pale yellow shades. According to the discoverer, this bacillus is pathogenic for all kinds of house-, field-, or wood-mice, and migratory and common rats. For the latter Danjsz prepared a stronger virus (No. 2)‡ by means of cutaneous injections and successive inoculations from animal to animal. It is harmless to man and all domestic animals.

Zupnik, who studied this bacillus comparatively with that of Löffler, found the virus to consist of a mixture of bacilli and cocci, more numerous in the first preparation than in No. 2; but after transmission through different animals it is possible to isolate those bacilli only which in microscopical appearance, cultures in broth and sweet gelatine, greatly resemble those of Löffler. He concludes that with regard to pathogenic power the *Bacillus typhi murium* is absolutely preferable to the *Coccobacillus murium*, because, whilst the first kills field-mice in ten days, the latter is only fatal in fourteen. It has not been tried on rats.

In 1892, Laser,§ at the Institute of Hygiene of Königsberg, also isolated from sick mice a short, very motile bacillus of a length equal to twice its breadth, staining better at the ends than in the centre. Field-mice infected by the mouth died in six, white mice in four days. After Löffler's experiments in Thessaly, Laser studied

* Translated from the *Revue d'Hygiène*, August, 1899, by H. E. A.

† The bacillus of Löffler is sold commercially by Schwazlose jun., Berlin, and that of Danjsz at the Pasteur Institute.

‡ Danjsz, 'Maladies Contagieuses des Animaux Nuisibles,' *Annales de la Science Agronomique*, 1895, vol. i.

§ Laser, *Cent. f. Bakt.*, 1891, xi., p. 184; 1893, xiii., p. 184; 1894, xvi., p. 33.

his bacillus, and found it to be harmless to the *Mus agrarius*, to cats, pigeons, geese, horses, pigs, or cows. Two sheep became ill and died, but at the autopsy the bacillus was not found in the organs. He states that he obtained satisfactory results in two trials in the field in Russia. Laser's experiments with this bacillus have not been repeated by any other person.

Mereshkowsky* also, who studied Löffler's bacillus in 1884, published in the following year the results of his researches on a malady very prevalent among a species of marmot (*Zieselmäuse spermophilus musicus*) in the district of Samara, Russia. The bacillus isolated by him closely resembled that of Löffler, but differed from it in not developing gas in sugared gelatine. House-mice infected by mouth died between the sixth and twelfth day, field-mice between the third and seventeenth. Rats (*Mus decumanus*) also were capable of infection, but showed only slight susceptibility. The bacillus was harmless to domestic animals. Experiments in the field yielded satisfactory results when tried by means of a cake made of rye flour and broth culture of the bacillus. This bacillus has not been studied by other experimenters.

The micro-organisms above described are the only ones with which the destruction of mice has been tried or proposed. Although the aim of the experimenters has been to obviate the harm to agriculture through these rodents, the pathogenic action of bacteria has been principally studied with regard to *arvicolæ*. As regards other species, the facts we know are insufficient or negative.

In the investigation of a micro-organism destructive to mice in reference to the prevention of plague, its action on species living habitually in contact with man should be taken into account, the more so since the field-mouse appears endowed with slight susceptibility as regards this infection.†

Existing conditions in the greater part of our town dwellings have given the exclusive dominion of the basement, in India as in Europe, to a single species of rat, viz., the *surmulot*,‡ or *Mus decumanus*, which has nearly everywhere driven out the black rat and others of the mouse species. In the basement, also, and in the interior of our houses the gray domestic mouse is still more common. Nevertheless, mice are, on the whole, only half as numerous as rats, although more prolific, because their places of concealment

* *Cent. f. Bakt.*, 1895, xvii., p. 742; 1896, xx., pp. 85 and 176.

† Abel, 'Sur la connaissance du bacille de la peste,' *Cent. f. Bakt.*, xxi., p. 497. One field-mouse survived the injection, and one died after six days; whilst one house-mouse died on the third day, and another on the fourth.

‡ The surmulot comes from India and Persia. It appeared in Russia in 1727, and in England, France, and Italy towards 1750.

are more accessible, and their mode of life renders them more subject to capture by man and animals.

We have not sufficient information to show which of the two species is the more susceptible with regard to plague. During the Bombay epidemic some observers considered that mice remained immune whilst rats died in great numbers. On the other hand, Simond at Bandora, and Bitter at Jeddah, reported that the mortality was great among rats and mice alike. Probably this discrepancy is due to the different behaviour of the two kinds of animal during the later moments of life. Rats, to escape from the sense of suffocation, come boldly out for fresh air, whilst the weaker and more timid mice die in their holes.

The results obtained in the laboratory are not much more instructive than observed epidemiological facts. Yersin and Hankin have shown that rats are more susceptible to plague than mice when infected by the gastro-intestinal tract, and conversely when the infecting matter is introduced subcutaneously; that the virulence of the bacillus is attenuated in passing from rat to rat, but that, on the contrary, it is intensified between white or gray mice. Since infection by the stomach appears the most ready and most common, it may be supposed that rats, under natural circumstances, are sources of greater danger than mice. But Yersen, Calmette, and Borrel* have demonstrated that in rats and mice alike infection by ingestion is not successful in causing plague due to human sources—at all events, when it has not had more than two or three transmissions through animals. If the digestive tract be the only dangerous channel, it must certainly be granted that mice are more refractory than rats, but with the latter the virulence soon becomes reduced if not maintained by frequent transmissions through man. Numerous observations appear to prove that the epizootic may last for a long time independently of man.

To explain the transmission of plague from the rat to man, Simond and Hankin have been led to admit the intervention of insects capable of transporting and inoculating the specific bacillus, as if this intervention could explain the relations between the disease in rats and in mice.

Regarding the question from the standpoint of general protection, rats are certainly more dangerous than mice, because of their greater ability to transport infection from place to place. What above everything makes these animals dangerous is their migratory

* Yersin, Calmette and Borrel, 'Peste Bubonique,' *Annales de Pasteur*, 1895, p. 589.

instinct, which becomes an uncontrollable scourge, carrying contagion from rat-holes into uninfected or already disinfected houses, distant quarters of a city or adjacent countries.

It has been observed in India that the general use of certain strongly-smelling disinfectants, such as carbolic acid, has the effect of driving away rats and mice. To prevent sick mice from leaving infected areas, Hankin proposes the use of inodorous disinfectants within these areas, and others of disagreeable smell at their margins and within surrounding uninfected zones. But it is questionable whether such a precaution will answer, since many towns have rat-runs both above and below the street pavements, along which the rodents may escape this form of sanitary cordon, so that it is not easy to intercept all of them. It soon becomes necessary to resort to means of destruction or expulsion of rats and mice from places inhabited by man, inasmuch as, if plague appears among them, nothing can check their emigration. Nevertheless, action to this end may have a contrary effect — in other words, may lead to a more rapid dissemination of the epidemic.

By chemical, mechanical, or physical means, and the use of the micro-organisms before mentioned—all of which have been found efficacious in this respect—the destruction of house-mice may be secured. In houses careful attention to the recommendations laid down as to the practical use of the above-named micro-organisms will succeed. On the other hand, the use of chemical or mechanical means will never be sufficient to destroy rats, but these measures may—in default of others—serve to exclude rats from dwellings. When circumstances allow of the closure of the drains and cellars, asphyxiating gases, smoke, sulphurous acid, bisulphide of carbon, etc.—or even flooding of these—may be employed with benefit.

No useful result against rats is to be anticipated from the employment of micro-organisms. The *Achorion Schönleinii* is pathogenic to man, but of slow and doubtful action in the case of the rodents. The bacilli of Löffler, Laser, and Mereshkowsky have no effect on them. The pathogenic effect of the coccobacillus of Danjsz, and especially the diffusibility of the disease it produces, have not been sufficiently satisfactorily demonstrated.

We know of many other bacteria pathogenic to mice, since these animals are so commonly employed in laboratory experiments. But for the very reason that rats are hardly ever made use of in the laboratory, our knowledge of their receptivity in respect of micro-organisms is most imperfect, and cannot be applied practically. The importance, however, of the part played by rats in the

spread of epidemic plague establishes the necessity of studying the most suitable means of securing their prompt destruction.

The French Government has not failed to consider this question, and has charged the Consultative Committee of Public Hygiene with its investigation. Certain navigation companies have already made great efforts to get rid of rats—which are so often the cause of heavy losses—sometimes even as much as several thousand francs for a single cargo. Notably in this respect may be named the Compagnie des Chargeurs Réunis, who have arranged with a special contractor for the destruction of the rats on their vessels, and are also taking the most strict measures possible at the ports of embarkation. The Compagnie des Messagerie Maritimes give their sailors a prize for the dead body of every rat caught on board, and this step has led to the destruction of large numbers.

Adopting the practice of the shipping companies, the committee have resolved to proceed methodically with the application of these and similar measures in hospitals and ships. As rats on shipboard are often very numerous, and the recesses in the cargo and structure where they take refuge many and difficult of access, the problem is by no means an easy one to solve. But, as is well known, satisfactory results may be obtained by care and attention; and with this view the following instructions recommended by Dr. A. J. Martin, and approved by the committee have recently been adopted by the President of the Council, Minister of the Interior.

Instructions as to the Destruction of Rats and Mice in Lazarets and Ships in Relation to Plague.

Rats and mice are very active agents in the propagation of plague. When they become affected, the disease rapidly spreads amongst the population of the places through which they travel or where they stay. The epizootic in these rodents precedes the human epidemic by a few days. Hence it is desirable at any price to exclude them from lazarets* and ships.

Lazarets.—It is most important to prevent rats and mice from penetrating into the structure of hospitals in any part. The greatest care must be taken to destroy all that have gained access. For this purpose all openings by which rats or mice can penetrate the structure should, wherever practicable, be closed, or otherwise be furnished with protective appliances, such as brushes, tubes, or, better, with metal screens. The hospitals should, moreover, be

* *I.e.*, floating hospitals.

provided with a sufficiency of such appliances to fix on all cables and moorings between the vessel and the land.

When there are rats or mice in hospitals, they should be trapped or poisoned, and their dead bodies should be immediately burned. If the rats or mice have secreted themselves in places difficult to reach, an asphyxiating gas, such as sulphurous acid (40 grains of sulphur to the cubic metre), should be used. The parts on which dead rats or mice have been laid should be washed with disinfecting solutions.

VESSELS—1. *At the Quay.*—When a vessel is at the quay the mooring-cables, etc., should be protected so as to prevent rats getting in or out of the ship by these means. Foot-bridges should be raised during the night.

Before lading, the absence of rats on board must be put beyond doubt. If there be any, or if their presence be suspected, measures such as those previously indicated must be taken for their destruction. Before lading it is important that the ship should be disinfected with sulphurous acid in all parts likely to harbour rats; other parts should be disinfected with a saline sublimate solution consisting of 1 gramme of perchloride of mercury and 2 grammes of sea-salt to a litre of distilled water. Dead rats should be burned.

2. *At Sea.*—On the voyage every available means must be taken to destroy any rats which may have got on board in spite of precautions taken at the quay. Measures securing their destruction without putrefaction or the disengagement of offensive smells are to be preferred. This result may be secured by the use of certain preparations, such as "*Mort-aux-rats*," which deserves a trial. The bodies of dead rats must be burnt, and the places where they are found should be disinfected.

3. *On arrival in Port.*—On boarding a ship for examination, the medical officer of health must carefully ascertain whether there are any rats on board. If the dead bodies of any be still on the ship, a bacteriological examination of these must at once be made for the purpose of finding the plague bacillus. If the bacillus be found, the ship must be discharged, the cargo and passengers' and crew's baggage disinfected, the vessel fumigated throughout with sulphurous acid, and the dead rats carefully burned. Otherwise the ship is to have free pratique after the completion of the regulation measures of disinfection.

After unlading at ports of discharge, ships are to be disinfected with sulphurous acid wherever this process is applicable, and elsewhere washed with a disinfectant solution.

The sanitary restrictions to be imposed on vessels will depend on the perfect execution of the foregoing instructions. The more thorough and the more promptly certain the destruction of the rats, the less need will there be to enforce them.

It is understood that special measures are actually in force to destroy rats in all the public buildings, and notably in the sewers of Paris. Attention to the dwelling cannot be too carefully bestowed.

Action of a Hard Water on Certain Metals (J. L. Howe and J. L. Morrison).—The water examined was found to corrode brass fittings; it contained per 100,000 parts: lime, 7·30; magnesia, 4·065; carbon dioxide, 30·196; sulphuric trioxide, 0·2127 part; chlorine, a trace. Strips of brass, zinc, copper, iron, lead, and aluminium were immersed in the water during four months, with and without access of air, and duplicate tests were made with distilled water. The results of the subsequent examination of the metal and water lead to the conclusion that waters of the above class, free from chlorine, attack zinc more readily than distilled water does, and dissolve out this metal from brass; they should, therefore, not be conveyed through zinc-lined iron pipes. The hardness of the water does not prevent it dissolving lead, the action being more than half as great as that of distilled water when protected from the air. When air is excluded, the action on iron is relatively slight, and this water has no influence on aluminium or nickel (*Journal American Chemical Society*).

Housing of the Working Classes.—On October 27th last the Corporation of Bradford adopted the following recommendations of the Sanitary Committee: "(1) That, subject to the approval of the General Committee, the Council be recommended in regard to the medical officer's representation under Part 1 of the Housing of the Working Classes Act, 1890, relating to property in the Longlands Street district, to acquire the whole of the properties referred to in such representation, with a view to an improvement scheme being formulated, and that accommodation be provided on such land for ninety-three through houses, and that other accommodation for persons displaced be provided by means of small through houses in other portions of the city. (2) That the Council be further recommended to adopt Part 3 of the Housing of the Working Classes Act, 1890." The Chairman of the Sanitary Committee, in moving the adoption of the resolutions, mentioned that the density of the population on the area was 301 persons per acre as compared with 21·6 for the whole city. The death-rates from all causes in the area were 45·6, 42·7, 41·2 and 50·8 per 1,000 in 1895, 1896, 1897 and 1898, as compared with rates of 19·8, 16·7, 17·9 and 17·5 in the whole city. Further particulars of the area will be found in Dr. Evans' paper, "The Housing of the Working Classes," published in this Journal in April last.*

* *Loc. cit.*, xi., p. 481.