

The cause and prevention of the spread of plague in India. : A lecture delivered before the Bombay Sanitary Association on 11th December 1907 / by W. Glen Liston.

Contributors

Liston, W. Glen.
London School of Hygiene and Tropical Medicine

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THE CAUSE AND PREVENTION

18.

OF THE

SPREAD OF PLAGUE

IN INDIA.

*A Lecture delivered before the Bombay Sanitary Association
on 11th December 1907*

BY

Captain W. GLEN LISTON, M.D., D.P.H., I.M.S.,

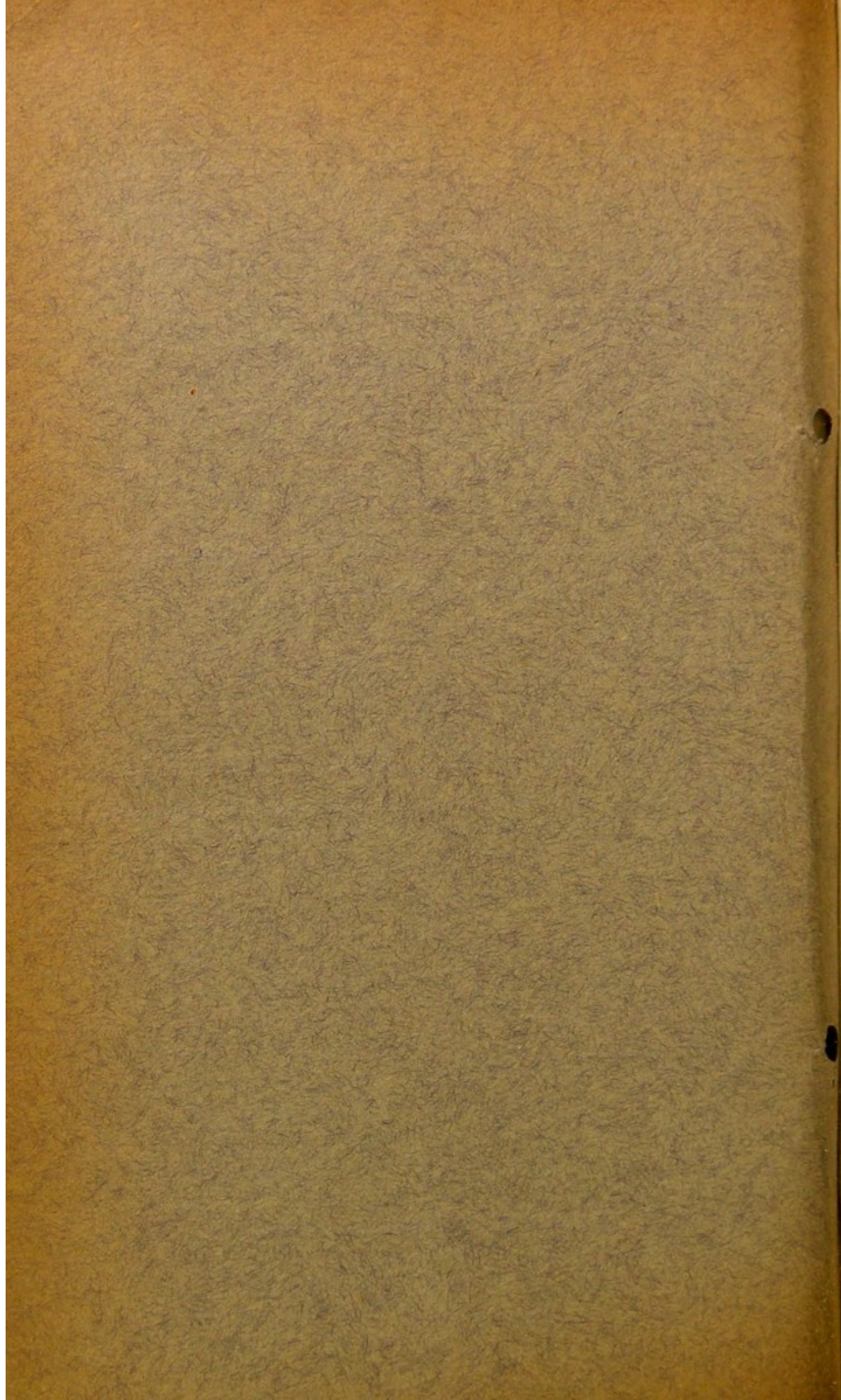
*Member of the Royal Society of Edinburgh, Member of the Plague Research Commission,
Acting Director, Bombay Bacteriological Laboratory, Parel.*



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THE CAUSE AND PREVENTION OF THE SPREAD OF PLAGUE IN INDIA.

PART I.

The Cause of the Spread of Plague in India.

DEFINITION OF PLAGUE.

Essentially a Rat Disease.

IN a paper which I had the honour of reading before the Bombay Natural History Society more than three years ago, I defined plague as essentially a rat disease which not infrequently was communicated to man. The disease among men might almost be said to be accidental and certainly avoidable if rats could be kept from association with man. At the same time I brought forward strong reasons in support of the view that the rat flea was the means by which the plague bacillus was transferred from the rat to man. Since then the Plague Research Commission, of which I was a member, has conclusively proved that rats are the chief source from which man acquires plague and has afforded the strongest possible grounds for inferring that man becomes infected through the agency of rat fleas which, previously to biting him, have fed upon infected rats.

It is not my intention to enter into any elaborate discussion of the observations which led the Commission to this important conclusion, but I shall very briefly describe the manner in which plague is spread, in order that the reader may understand the principles on which measures for the prevention of this disease in India should be based.

The Association of Rats with Men is the cause of Epidemic Plague.

It is possible to deduce from the definition of plague which has been given above that if there were no rats there would be no plague, and that it is the association of rats with men which is the direct cause of epidemic plague. It is necessary, however, to consider this deduction more carefully if our preventive measures are to be based upon it.

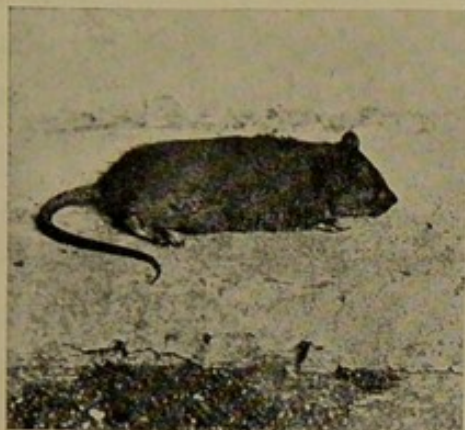
This Association of Rats with Men is Dependent on the Habits of Rats and on the Customs of the People.

If we study the causes of the association of rats with man we find that this depends partly on the habits of the rats and partly on the manners and customs of the people.

The Habits of Rats vary according to the species to which they belong.

Let us consider first the habits of rats which bring these animals in proximity to man. The habits of rats vary according to the particular species to which they belong. There are many different kind of rats, but we may divide them for convenience into field rats and house rats. This will not be a very accurate division, because some field rats enter houses and some house rats are occasionally found in the fields. The house-frequenting rats are of prime importance so far as plague in man is concerned. There are at least four common house-frequenting rats met with in India, but they do not all play an equally important part in the spread of plague. Two of these four kinds of rats we can dismiss very shortly; they both belong to the genus *Nesokia*,—a group of rats more familiarly known as bandicoots. Before plague was introduced into Bombay the large bandicoot was frequently seen in houses, but it is now a very rare rat in that city. Occasionally, however, the lesser bandicoot known as *Nesokia bengalensis* is met with. Among a very large number of rats found dead and caught alive in Bombay city and examined by the Plague Commission this species constituted only 1 per

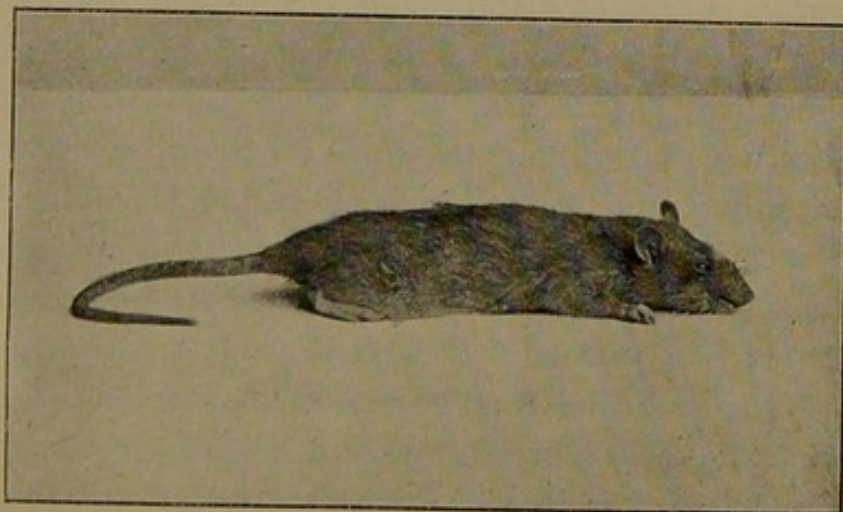
cent. of the whole. The chief interest in this rat arises from the fact that it can very easily be mistaken for a more common house-frequenting species.



Nesokia bengalensis. The lesser bandicoot.

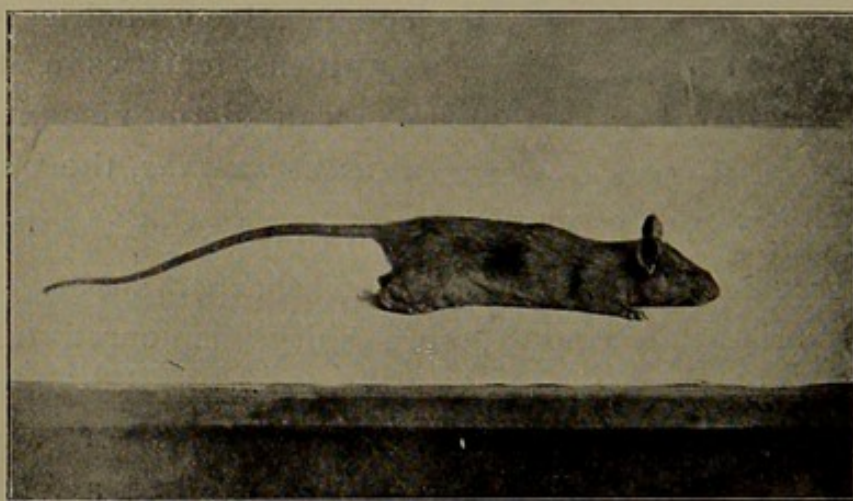
This photograph of a specimen of *N. bengalensis* shows well the chief external characters of the species. Note the short stumpy pig-like face, broad forehead, large ears, rough bristly fur and short comparatively hairless tail. By these features a trained eye can distinguish it from *Mus decumanus*, the "sewer" rat, which it closely resembles.

Mus decumanus has a longer and sharper snout, smaller ears, less bristly fur and a more hairy bicoloured tail, the dorsal surface of which is darker than the ventral. This rat is comparatively rare in India. Indeed it is never found in inland villages, and has only recently established a footing in some of the larger Indian seaport towns. It is found in Bombay city where drains and sewers exist, but it cannot be captured in the suburbs where drainage systems are unknown. *Mus decumanus* lives in burrows and drains, for the most part constructed outside of human habitations, but it enters houses



Mus decumanus. The sewer rat.

for food. It feeds on garbage of all kinds, is a dirty rat, shy and timid in manner, shunning the society of man, but living upon the refuse he leaves. *Mus decumanus* has an interesting history. It first made its presence manifest in England and some other European countries coincidentally with the disappearance of plague from them. The rat is said to have been imported from Norway, hence it has been called the Norwegian rat. It gradually displaced in England another species of rat to which I shall now draw your attention.



Mus rattus. The house rat

This other rat, *Mus rattus*, was common in England in the early plague period. It has therefore sometimes been called the old English black rat. It is the common house rat of India.

Mus rattus is readily distinguished from *Mus decumanus* by its long tail and large ears. It is a neat, clean living creature, very domesticated and constantly associated with man. It lives and breeds in human dwellings; in cupboards, beneath boxes or among any sort of lumber. It finds ideal conditions for existence in Indian houses. Intimately associated with man, it readily finds shelter on ships and trains among the materials placed on board for transport. It frequently makes for itself burrows in the earthen floors and walls of huts in Indian villages, there it breeds and multiplies with great rapidity feeding upon the grain and other materials stored in the house.

In the Island of Bombay there are probably three of the "sewer" rats, *M. decumanus*, to every seven of the "house" rats, *M. rattus*.

Mus Rattus is a Plague-spreading Rat because of its habits.

That *M. rattus* is the most important plague-spreading rat in India has been amply proved by the Plague Commission. Through the assistance of Dr. Turner and his staff, the Commissioners were enabled to secure for examination a large number of rats found dead or trapped alive in Bombay City. They were thus able to record each week the number and species of the plague infected rats found. The examination and record was continued for a year, and the mean weekly number of infected rats of each species for that period was calculated. The Commission was also supplied with figures of the weekly human mortality from plague in the city, and so were able to calculate a mean weekly human plague mortality figure for the year. In the table on page 37 the figures in each column express the weekly number of plague-infected rats of each species and the number of deaths from plague as a percentage above and below the corresponding mean weekly numbers for the year.

The Plague among Mus Rattus precedes the Plague among men by an Interval of a Week to a Fortnight.

From a study of Table I we can compare the progress of the plague each week among (i) *Mus decumanus*, (ii) *Mus rattus*, and (iii) Men. It will be seen that in all three cases the percentages rise above the mean for about 14 to 16 weeks only. A better conception of the significance of these figures can be gained by depicting them on a chart.

Three curves are thus obtained : the one marked in with dots represents the course of the disease among *M. decumanus*, the thin line shows the progress of the disease each week among *Mus rattus*, and, lastly, the thick line depicts the course of the human epidemic. The rise and fall of the disease among

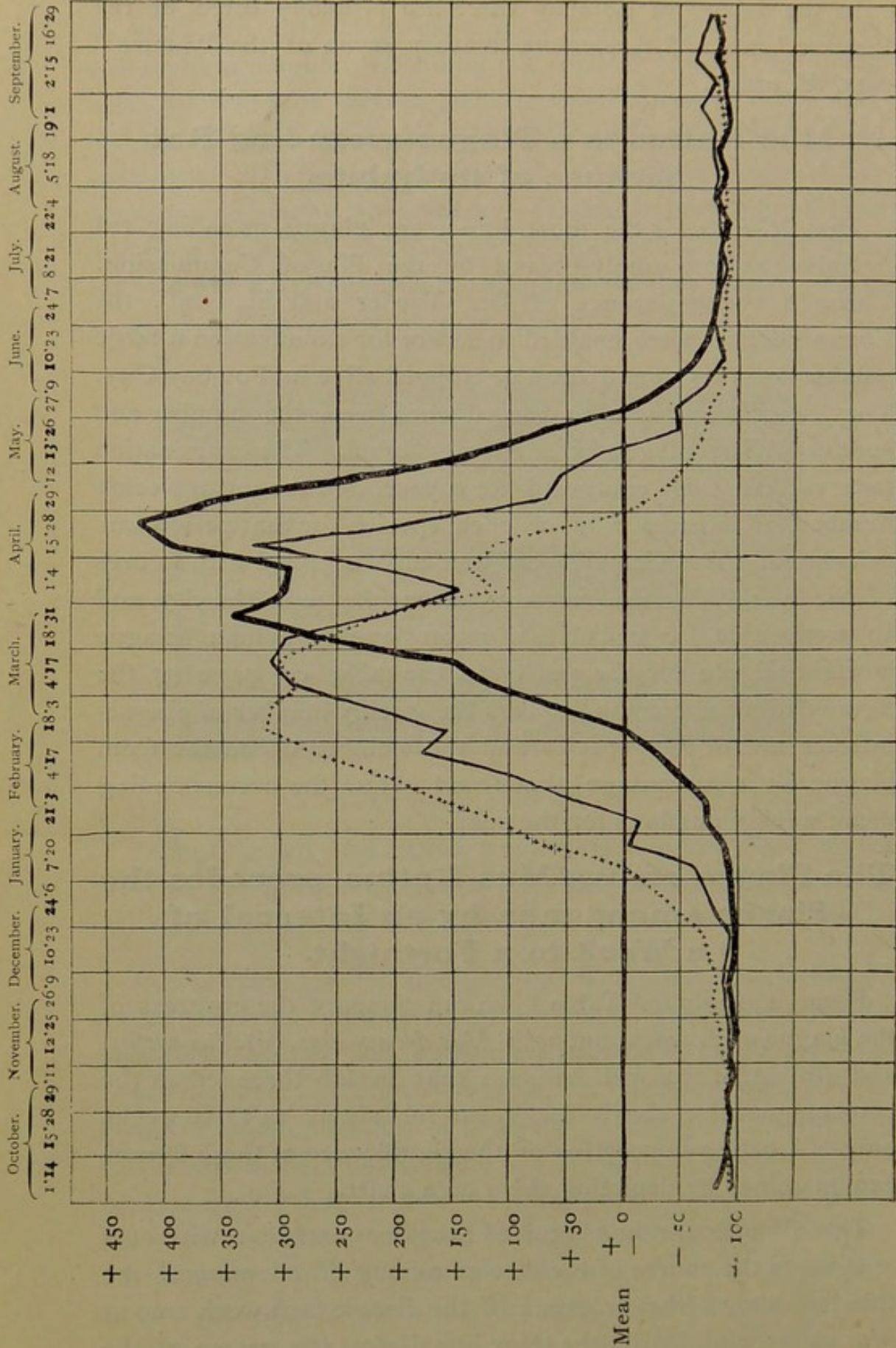


CHART I—Showing the progress of the plague in

..... Infected *M. decumanus*.
 — Infected *M. rattus*.

“Sewer” rats, *M. decumanus*, does not coincide with that of disease in man, but begins a month earlier, and plague among *M. decumanus* has already reached its maximum, and is declining while plague in man is still on the increase. On the other hand, the progress of plague in man follows very closely that of the disease among the “house” rats, *M. rattus*. Every lesser wave in the curve of the disease among *M. rattus* is also represented in the curve of the human epidemic, but at an interval of from a week to a fortnight later.

Some idea of the intimacy of the correlation between human plague and plague in *M. rattus* can be gathered when it is stated that it has been mathematically calculated from figures supplied by the Plague Commission that the correlation coefficient of human plague with the *rattus* plague of the second previous week is $\cdot9407$ with a possible error of $\pm \cdot0096$. Statisticians generally consider a correlation co-efficient very large when it is greater than $\cdot75$. We may conclude, then, that the relationship between the incidence of plague in man and plague in *M. rattus* is extremely close.

The Commission, as the result of exhaustive inquiries in certain small villages, where *M. rattus* was practically the only rat caught, were able to show that the correlation in time found to exist between plague in *M. rattus* and plague in man held good also as regards space. Where rats died, there a week to a fortnight later human cases commonly occurred. They were thus able to conclude that plague in *M. rattus* is the direct cause of human plague in India. It is the habits of *M. rattus*, the house-rat, that make this rat so important a plague-carrier.

Some of the Habits of the People favour the Multiplication of Rats.

We have so far considered the habits of rats which bring these animals into association with man. We may now pass on to briefly consider some of the manners and customs of the people which favour the presence of *M. rattus*, among them.

The Structure of Indian Buildings affords Shelter to Rats.

And first we may consider the structure of the houses in which the people dwell and observe that the character of the buildings favours the presence of rats.



This photograph shows the appearance of a common type of Indian dwelling. The walls are built of unhewn stone, plastered together with mud and maintained in an almost constant



state of disrepair. The roof, too, affords ample shelter for rats beneath the country tiles. If we enter a room in the upper storey of such a house, a picture, much like the one depicted at the foot of the last page, will confront us. We will have entered a small room 10 feet by 10 feet with a sloping roof. The roof at its highest part may be perhaps just a little over 6 feet above the floor, and, stretching downwards, it meets the floor at one side of the room. It is difficult to move about in such a place, yet this room may be inhabited by three or four adult persons. No window is to be found in the room, what light enters it comes in through the door and through gaps in the tiled roof.

The Promiscuous Letting and Occupation of Buildings brings about the Association of Rats with Man.

While from their structure the buildings are adapted for the lodgment of rats, the buildings themselves are let in such a manner as to favour the rodents. It is a matter of indifference who

occupies the buildings or what is kept on the premises, provided only a good rent is obtained.

Here we have a picture of a first class dwelling house with a grain shop situated beneath it.

In every street many buildings let in this manner are to be found. The grain is placed in baskets or in open sacks, exhibited to the view of persons walking on the street. At night it is often left uncovered, so that rats gain ready access to it. Nor does the shopkeeper grumble or complain that



some of his grain has been eaten by the rats ; he may be a Hindu who considers it a sacred duty to protect and feed such animals.



This is another house with a stable below it. In the towns in India no bye-laws exist which prohibit the keeping of horses or cattle within a limited distance of a dwelling-house. At least if such laws have been enacted, they are seldom enforced. In almost every part of an Indian town stables will be found immediately below dwelling-houses, and their presence in such situations appears to occasion no repugnance on the part of the inhabitants. Wealthy Indians sometimes even

convert the porch over their front door into a stable.

In this street the ground floors of all the houses are used as stables or store-houses. The ground floor of practically every building in Mandvi district of Bombay—a badly infected area—is used as a godown, while people live in the upper storeys.



**Apart from the Structure of the Buildings,
the Habits of some Indians conduce to
the Presence of Rats among them.**

The habits of the people are still more important in producing and maintaining a close association between rats and men. Even the erection of well built rat proof dwellings will not of itself stop the plague. The Improvement Trust, for example, have erected a series of well built chawls in Agripada.

The walls of these buildings are solidly constructed of brick raised on a high masonry plinth. The floors are made of concrete or patent stone, and the building is roofed with Mangalore tiles. The verandahs and corridors are paved and are wide and

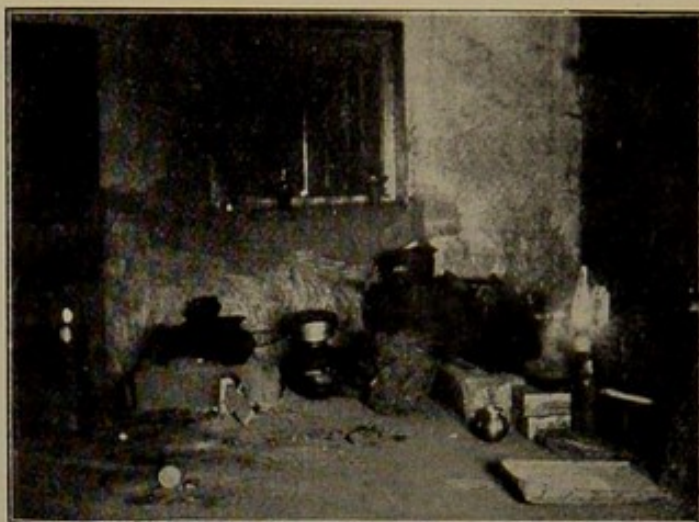


The Improvement Trust Chawls.

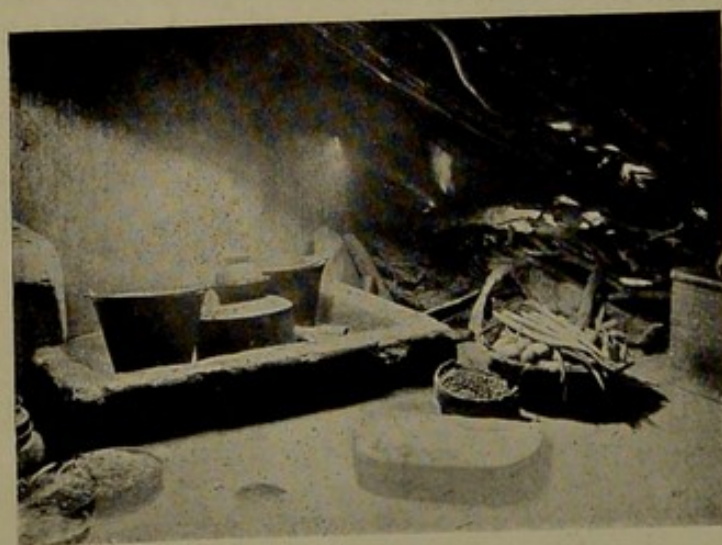
airy. The lighting and ventilation of the whole building leaves nothing to be desired. The sanitary arrangements are excellent; there are no gullies. In short, the buildings in themselves offer no shelter to rats. In spite of this, *Mus rattus* is common in the houses, and it is certain that their presence is entirely due to the habits of the people in the matter of the disposal of their household belongings and food supply. Grain and grocer's shops are to be found on the ground floors, and here the rats find food and shelter. In the upper storeys the inhabitants construct shelves and accumulate there materials which are seldom disturbed, and among which the rats live. In the plague season of 1906 these chawls were so badly smitten by the disease that they had to be vacated, and the incongruous spectacle was presented of the empty chawls and the inhabitants living in matting huts. The population of the chawls was about 4,000, and of this number no less than 57 were attacked by plague. There was a considerable mortality among the rats in the building; some of the rats were examined and observed to be infected with plague.

Poverty and a Lack of General Order and Tidiness within the Household favours the Plague.

This photograph shows the interior of an ordinary Indian dwelling, the accumulation of rubbish and general disorder is evident. The walls of the room are soft and readily penetrat-



ed by rats, for mud or inferior lime is often used to hold the stones together. The floor is made of rammed earth covered with a layer of cowdung. The furnishings are of the simplest kind; a lamp, a few earthenware and brass pots, some boxes and baskets make up the complete outfit. Scattered about in various parts of the room are collections of firewood and bundles of sticks. A grinding stone or "chakki" may occupy one corner.



This is another picture which shows the conditions which permit of the association of rats with man.

It is a picture of a small room measuring five feet by seven feet. It was

tenanted by four adults. The roof sloped towards one end of the room where it touched the floor, and at its highest part only measured five feet from the ground, so that it was impossible to stand in any part of the room.

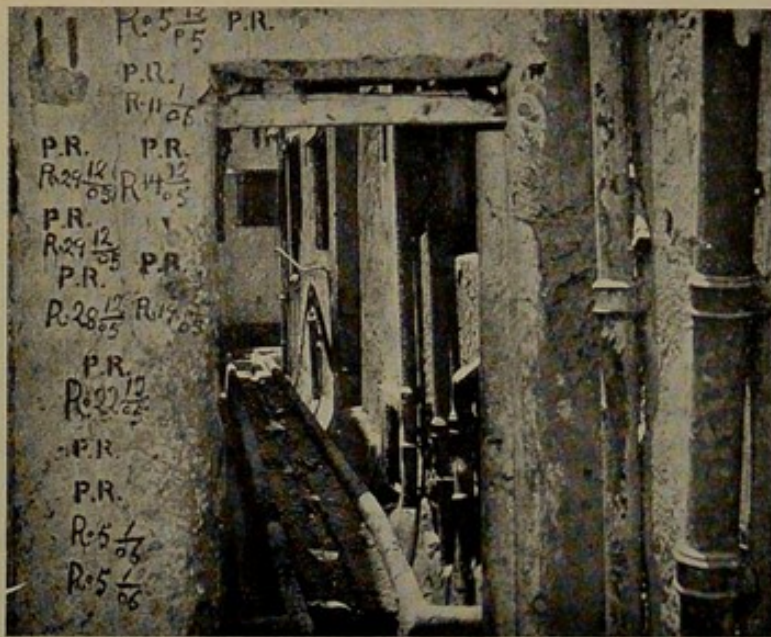


Look at this picture. Is it wonderful that rats find shelter in such circumstances?



The Habit of using the Street as a Depository for Filth and Refuse affords a Food Supply for the Rats.

A supply of food for the rats is to be found everywhere. Visit the gullies in the city and you can see, even while you wait for a few minutes, quantities of rice and other food material thrown out of the windows. This is a photograph of a gully taken an hour or two after it had been swept out.



Observe the refuse accumulated in the central channel. The marks on the wall show that the gully has been badly infected by the plague. Each "P.R." with date indicates that on that

particular date a rat has been picked up here which was proved to be infected with the plague. There is here a record of at least ten plague-infected rats picked up on different dates between the 5th of December 1905 and 5th January 1906.

The Keeping of Cows, Goats and Hens in Human Dwellings attracts Rats to them.

There is another habit of the people which favours the presence of rats among them, namely, that of keeping animals, particularly cows, goats, and hens in their dwelling rooms. These animals during the day feed upon grain and all sorts of food material which becomes scattered about the street, affording food for rats.

Among the poorer classes in India, and it should be remembered in this connection that in a city like Bombay eighty-five

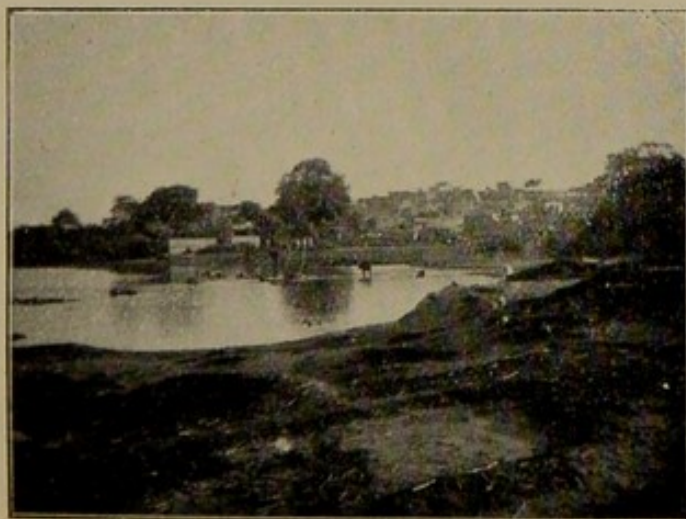
per cent. of the population live in a single-roomed house, it is the almost constant practice of the people to keep either hens or goats in their dwelling room. The hens furnish the inmates with eggs and meat, while the goats supply them with milk.



In this photograph of a small portion of a street you can count no less than seven goats.

These conditions which associate Men with Rats are to be found throughout India.

Wherever you go in India the same story holds good. It is a country admirably adapted for the multiplication of rats.



Let me take you to the Punjab. Here is a village scene; observe the village cattle enjoying themselves in the village tank. These cattle will at night share their owner's dwelling. Let us enter

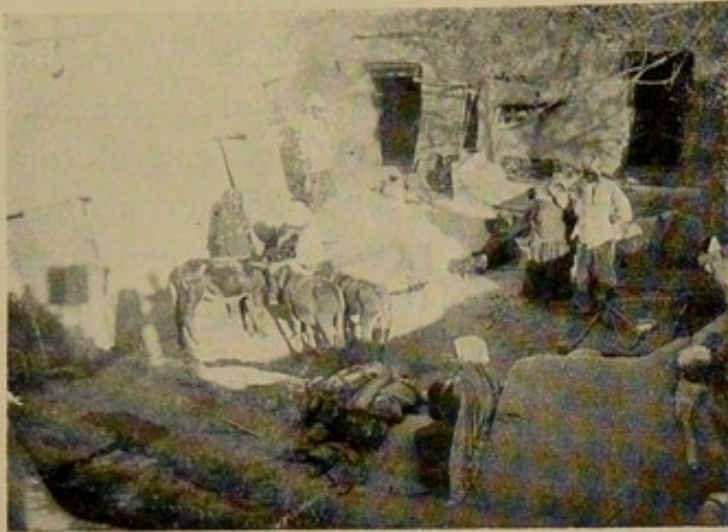


one of these dwellings and we shall find the stall or room for the cattle, and passing from it through the sleeping room of the family, we enter by another door, a room in which the grain supply for the year is kept, stored in large earthen vessels. These large grain bins are called "khoti" or "barola" according to their shape. In addition we may find a number of earthen pots or "gharas" within the room. Spices,

chillies and onions are stored in the "gharas." The rooms are generally very dark; windows are rarely found. Outside the door at one side of the house a ladder or staircase leads to the roof. Climbing on to the flat roof of the house, we note that this is used as a store for all sorts of materials and



looking down into the courtyard below we observe some animals tethered. Could more ideal conditions be obtained for



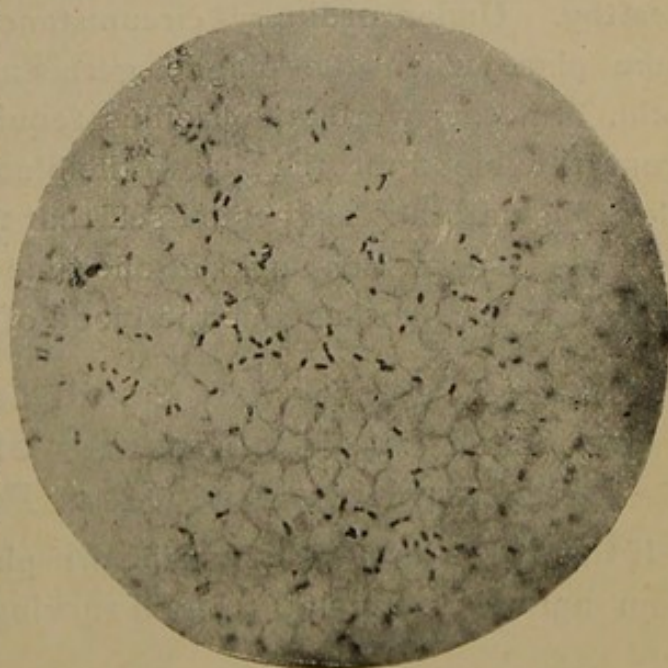
the life and development of rats in the very midst of the human population!

It is the presence of *Mus rattus*, the "house" rat, amid people with

habits and customs such as I have illustrated, that accounts for the presence of plague in India.

The Common cause of Rat and Human Plague is the Plague Bacillus.

Before we can go further, we must consider how the infection of plague is conveyed from rats to man. Almost everybody now knows that the disease is due to the presence of a minute germ or bacillus, which is found in the blood of the person or animal suffering from the disease. This is a photograph of a very thin film of the blood of a plague infected rat. The film has been suitably stained and magnified very greatly. The germs are seen as little dark rods amid the circular red blood cells. These little germs are so minute that sixteen thousand of them would require to be placed end to end so as to make a chain one inch long.



**The Plague Bacillus is a Delicate Organism
that can only exist in the Body
of a Living Animal.**

Although growing luxuriantly in the juices of the bodies of animals the plague bacillus is a very delicate organism, and it requires a very special soil for its existence and multiplication. It cannot live under natural conditions for many days outside the body of a live animal for example on earth or other surfaces. In such surroundings it meets with many other organisms which find in these situations a congenial soil in which to multiply and the plague bacillus is crushed out much as the more delicate plants in a garden are choked by weeds. Like garden plants however the plague bacillus may thrive when freed from weeds; it is in this way that the germ is cultivated in the laboratory. For these reasons then the disease can only exist so long as the plague germ can be transferred from animal to animal.

**The Germ is generally transferred from
animal to animal, from the Blood of the
Sick to the Blood of the Healthy.**

The Plague Commission and others have shown that the mere handling of plague infected animals, or living in contact with persons suffering from the disease, is not as a rule the means by which infection is conveyed from the sick to the healthy. Under ordinary circumstances infection can only take place when the plague germs are injected beneath the skin. In other words the bacillus requires to be transferred from the blood of the sick to the blood of the healthy. The idea thus naturally suggests itself that this can best be effected by some insect which sucks at one time the blood of a sick animal and at another time the blood of a healthy one.

**This transfer of the Germ from the Sick to
the Healthy is generally effected by the
Bloodsucking Rat Flea, *Pulex cheopis*.**

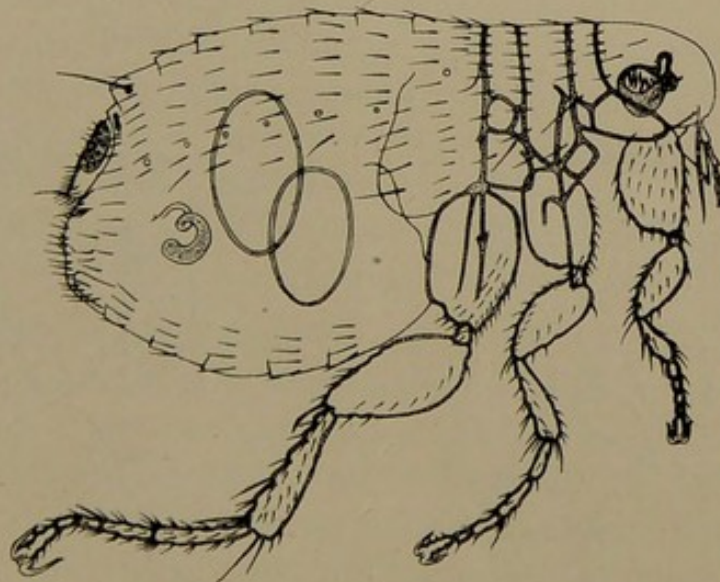
If this is the agency by which the plague germ is passed from animal to animal, a blood sucking insect must be found

which will feed not only upon rats but under certain circumstances also upon man. A search in this direction soon led to the incrimination of the rat flea, *Pulex cheopis*, a picture of which is produced below.



Male *Pulex cheopis*.

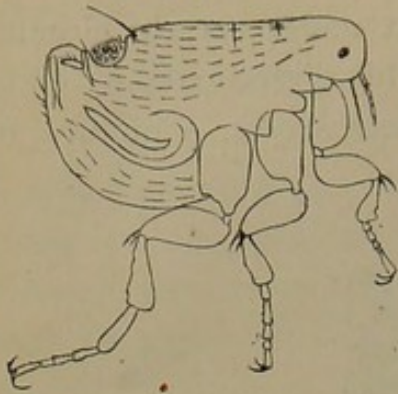
This is a photograph of a careful drawing made from a male *P. cheopis* magnified many times under a microscope. This other picture represents a female of the same species.



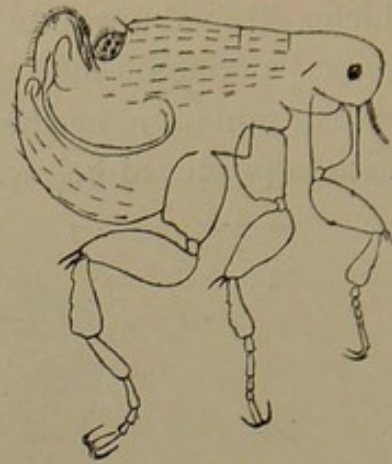
Female *Pulex cheopis*.

Every bristle you see has been carefully drawn to scale, for these bristles are of use in distinguishing one species of flea from another.

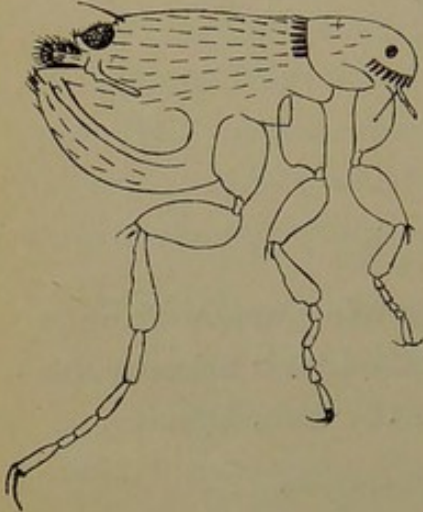
♂ *Pulex cheopis*



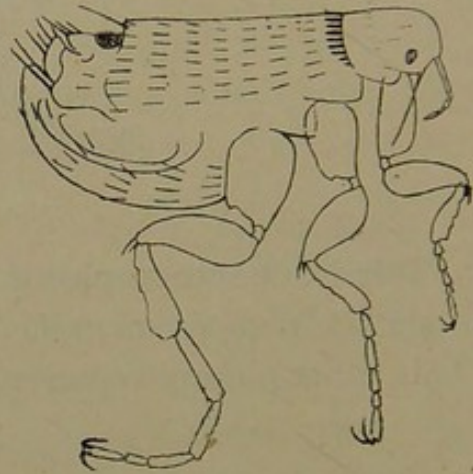
♂ *Pulex irritans*



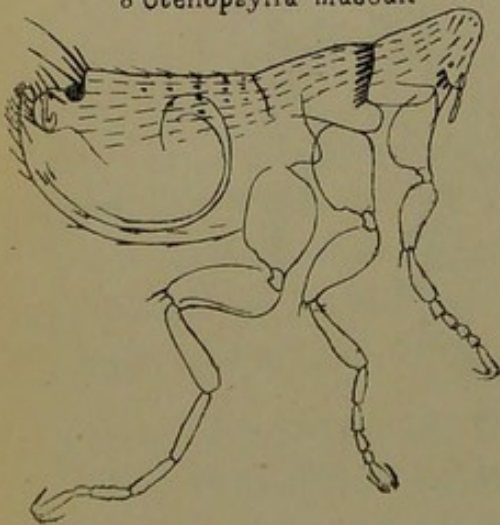
♂ *Pulex felis*



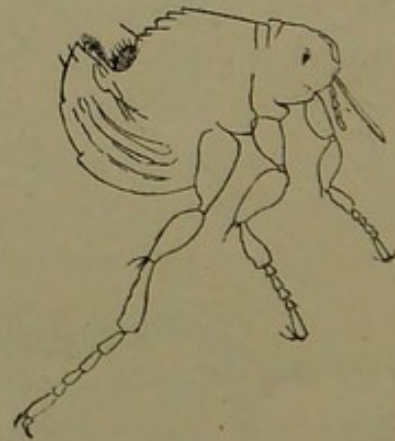
♂ *Ceratophyllus fasciatus*



♂ *Ctenopsylla musculi*



♂ *Sarcopsylla gallinacea*



Some fleas which have been found on rats.

There are many kinds of fleas some more particular than others in the selection of their host.

I have often been surprised how little people know about fleas, some do not even care to mention them save with bated breath ; particularly is this the case in England. Others do not even know what these insects are like, and I find this to be commonly the case in this country. However, there are fleas and fleas, and the study of these insects is full of interest. This picture illustrates a few of the more important kinds of fleas which have been found on rats.

It is necessary here to say a word or two on the habits of fleas. *P. canis*, commonly called the dog flea, is not very particular in the selection of its food. It will suck the blood of dog or cat, rat, man, horse, goat, guinea-pig, hedge hog, kangaroo, rabbit and a number of other animals, although it prefers to feed on a dog or a cat and will select these animals in preference to others when they can be found.

P. irritans, which is the human flea, is, on the other hand, very select in its choice of the animal on which it feeds. It is seldom found on any other animal than man.

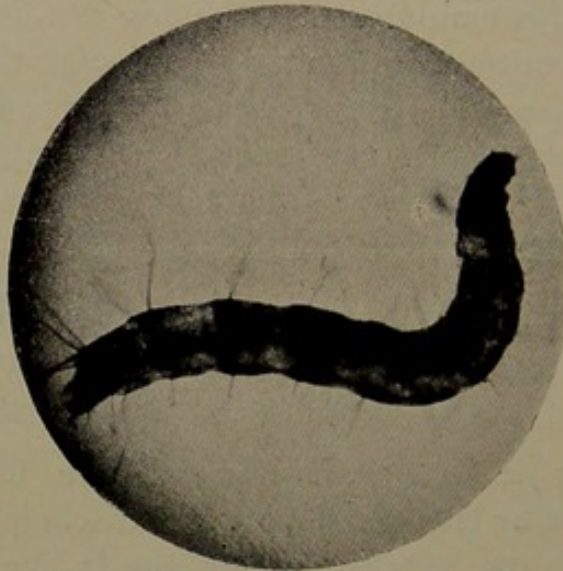
Ceratophyllus fasciatus, the common flea found on rats in Europe, is more or less particular in its choice, being found generally upon rats. *Pulex cheopis*, the Indian rat flea, unlike *Ceratophyllus fasciatus*, readily feeds on a number of animals. *In the absence of rats it will bite man*, especially when it has been starved for two or three days, but when rats are available it will leave man to take to the rat.

This peculiar habit of fleas in selecting the animals upon which they choose to feed, explains many facts connected with plague which were not understood before the discovery was made that fleas are the agents which transmit the disease from animal to animal. For example it had often been observed that plague did not attack man until a few days after rats had died. The order of events was recognised to be, first plague among rats, then a lull, and this was followed by plague among men. We now understand that the lull can be explained by the fact that rat fleas seldom attack man till forced by hunger to do so. It is because there is a latent period

after rats have died and before man becomes attacked that evacuation of an infected premises in some instances can be carried out with advantage.

Fleas spend a great part of their existence on the ground, not on their host.

Another habit of fleas which is not generally known and which is of importance in connection with the spread of plague is, that fleas do not always live upon their host, but spend a large part of their life on the ground where they lay their eggs. Here, too, the larva lives and feeds.



Larval flea magnified.

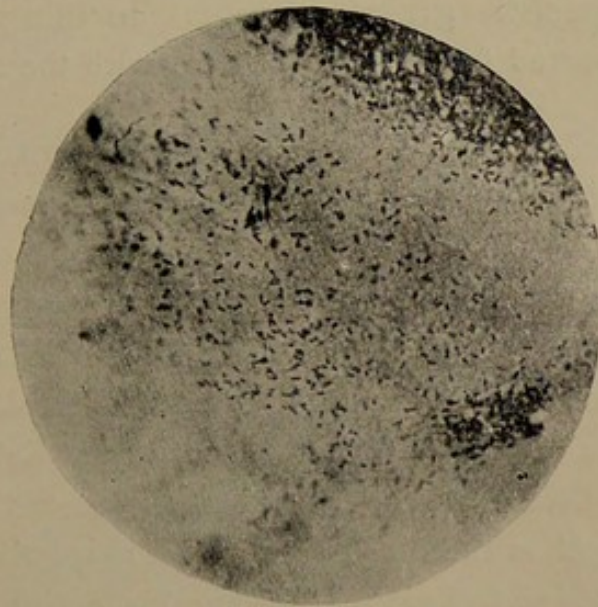
This is a magnified picture of a larval flea. The pupa is also found on the ground. The imago, or fully fledged flea, as a rule, lives upon an animal only so long as it requires some food, and leaves the host as soon as its hunger is satisfied. When hungry it again seeks a fresh host. In this way the rat flea, *P. cheopis*, passes from rat to rat seeking by preference this animal, but in the absence of it choosing man, cat, squirrel, monkey, or other suitable animal.

The habits of fleas in this respect contrast with those of certain other animal parasites, for example with lice. These latter insects confine themselves far more closely to a particular animal than do fleas, and they live and multiply upon that

animal. The majority of fleas on the other hand are constantly changing their host, and they do not breed upon the animal on which they are found. When fleas increase in numbers upon an animal they must have gained access to it from the animal's surroundings. Fleas are most abundantly found in places much frequented by their respective kinds of hosts, for example in the dwellings or nests of their hosts.

Plague germs can multiply in the stomach of a Rat Flea.

If plague is spread by the flea, it is essential that the plague germ should not be destroyed in the body of the insect. As a matter of fact we find that when plague bacilli are sucked into the stomach of a rat flea together with the blood of a sick rat, under certain circumstances, the germs begin to multiply.



Smear from the stomach of an infected rat flea magnified about 850 times.

The picture shown above is a magnified photograph of a smear made from the contents of the stomach of an infected rat flea. It will be observed that the number of bacilli is here much greater than was seen in the blood of a plague-infected rat. The bacilli have multiplied in the flea's stomach. We have then in the rat flea an ideal transmitter of the plague organism. It removes the bacilli from the blood of a sick rat, the bacilli multiply in its stomach, and then it transfers them from one healthy rat to another, till at last the rats are killed off by the disease, and from hunger the fleas take to man.

Rat fleas cannot travel far unless carried by a host. The rat is the common host of *P. Cheopis*, but man occasionally carries these fleas on his person or clothing for long or short distances.

Rat fleas cannot on their own legs travel great distances, twenty or thirty yards would constitute for them a long journey,* but carried by a host they can cover some distance. *Pulex cheopis*, the rat flea, is most frequently carried by rats from place to place ; but as rats usually confine themselves to comparatively small areas, and do not wander far from their holes, infection can only be spread in this way to a limited extent. At times, however, rats are carried in trains and in ships for long distances concealed among various articles of commerce, especially grain and rags. In this way rat fleas may be transported from place to place with the rats.

Another method by which transference may take place is by the carriage of these insects by man on his person or in his clothing for long or short journeys. This means of transporting rat fleas is most likely to occur when rats having suddenly become scarce the rat fleas seek man to feed upon. These conditions are most often found in a plague infected house. People coming from such houses are liable, therefore, to harbour rat fleas on their person and some of these fleas may carry in their bodies the plague germ. Thus it comes about that rat fleas are carried to healthy areas and when introduced there, they leave man and seek the rats. If the rats are bitten by infected fleas plague may break out among these animals and later, in turn, man may become infected. In short, it may be stated that rats are usually responsible for the spread of plague in an infected locality, but that man not infrequently carries infected fleas from an infected place to a healthy area at a distance.

PART II.

*The Prevention of the Spread of Plague in India.***Preliminary considerations.**

From the conclusions which have been arrived at above regarding the means by which plague spreads epidemically it is clear that if rats were eliminated there would be no outbreak of bubonic plague in man. Every effort must therefore be made towards diminishing the number of rats and minimising the accessibility of rats to man. This is a difficult task everywhere, but particularly so in India on account of the customs and prejudices of the people.

**The rat infestation of Indian houses
is enormous.**

The rat infestation of Indian houses is enormous. The Plague Commission in connection with their observations on the epidemiology of plague in certain villages both in Bombay and in the Punjab found that it was possible to remove from a village during the course of one year a larger number of rats than the total human population without very seriously reducing the number of rats still remaining alive in the villages. From some houses in particular a large number of rats were captured. The little picture reproduced below has been made



from a photograph of a house in the village of Parel. The particular building referred to is the one in the centre of the picture. It is an old building which has seen better days and is now tenanted by seventy-one persons. The ground floor of the building was

let to two grocers and grain merchants who had their shops there. In this building during one year more than three hundred rats were captured. The picture on the next page illustrates another badly rat infested house; eighty-eight rats were taken in it during the course of one year.



The number of rats present in any place depends on certain laws which regulate the struggle for existence.

Darwin has shown that the number of individuals of any particular species present in a locality depends on certain laws. If these laws did not exist animals would multiply to an unlimited extent at a geometrical ratio of increase, so that a time would come when there would be no room in the world for all. A struggle for existence thus inevitably follows and this struggle is conducted in accordance with the above mentioned laws. It is as hopeless to run counter to these laws in an attempt to diminish the number of animals present in any place as it is to attempt to upset the law of gravity. It is necessary, therefore, to consider these laws, so far as they are known, if we wish to reduce the number of rats in a particular locality.

In the absence of natural enemies, disease, etc., rats will exist in numbers proportional to the food and shelter they find.

Animals cannot exist without food and, in the absence of the operation of other checks to their multiplication, will be present in numbers proportional to their food supply. Even if food be abundant in the absence of shelter the numbers of any particular species of animal will be limited. Thus the number

of rats in any place will directly depend on their available food supply and shelter; diminish these and the number of rats will be proportionately decreased.

Measures which aim at decreasing the shelter and food supply of rats are measures of permanent utility in the fight against plague.

From what has been said above it is obvious that measures which aim at decreasing the food supply and shelter afforded to rats will be of permanent value in the fight against plague. Such measures are concerned with the reforming of those manners, customs and modes of living of the people which afford shelter and a food supply for rats and bring about the association of rats with man.

Measures of permanent utility,

Measures of permanent utility in the fight against plague deal with the drawing up and enforcing of regulations to prevent the erection of flimsy and ill made buildings and which insist upon the maintenance of houses in a proper state of repair. Too frequently in India dilapidated houses, often unoccupied, not only disfigure the towns and villages, but afford shelter to rats. Of permanent utility are measures which make places that are likely to harbour rats proof amongst these animals. Regulations which provide that dwellings should be kept apart from grain stores, godowns and stables, when carried out, are sure to lead to the permanent elimination of the plague. In most Indian towns and villages a better system for the collection and removal of house refuse is urgently needed. Above all an endeavour should be made to prohibit people from using the gullies and public streets as depositories for food refuse. The Health Departments in the cities should insist on tenants maintaining in a clean and tidy state not only their own rooms, but also the stairs and corridors of their dwellings. Housing Acts should be passed and rigidly enforced empowering the Health authorities to deal with these matters. The keeping of animals in

dwelling houses should be strictly prohibited. Such reforms will take time to carry out, but a beginning must be made. Rules are of no use when they are framed so that they can be evaded. Action must be taken, the occasion demands it.

A beginning can best be made in the larger towns where education is somewhat advanced. It will be hopeless to expect to carry out reforms of this nature in the villages where education has not progressed enough. When the cities have purged themselves of the blemishes detailed above the villages will be directly benefitted, for the cities are the great distributing centres of the disease. The only action that the unfortunate villagers can take in the meantime is to insist on a modified form of quarantine and prevent those who have come from infected places entering their village until they have taken measures to rid themselves of any fleas they may have brought with them on their person or in their kit. These measures of permanent utility are the only anti-plague measures which will ultimately drive plague out of the country. They are the measures which have driven plague from the Western nations. On account of the radical nature of these measures few have the courage to enforce them on an unwilling people, but with patience and example great progress can be made. It behoves all educated Indians who have experienced the advantages of these measures to assist in instructing their less favoured countrymen. Tidiness and order should be the watch words of this policy. This is the policy of rat exclusion as contrasted with the policy of rat destruction which we will next consider.

Rat Destruction.

Rat destruction as an anti-plague measure has the great advantage that it interferes little with human comfort. Indians who have experienced a temporary freedom from rats have recognised the advantages of living without these pests; the absence of rats insures less disturbance at night and less injury to and loss of property. The disadvantage of rat destruction however lies in the fact that to be successful this measure must have the complete co-operation of an entire commu-

nity, and the operations must be extensive and sustained. The destruction of rats either by the use of chemical poisons or by the dissemination of bacterial diseases among them has not proved as successful as was anticipated. It must be remembered that no more efficient rat destroyer than plague itself has yet been discovered. The failure to keep down rats by poisoning them arises from the fact that the operations have, as a rule, only been temporarily carried out and can never be persistently maintained except at great cost. Trapping rats alive and then destroying them has yielded better results when daily practised.

To what extent this measure must be carried out can best be illustrated by describing the rat catching operations of the Plague Commission in the village of Worli. The village of Worli has a population of about 2,508 souls. Every day for a period of nearly one year traps were set in the buildings of the village in rotation. On an average 35 traps were set each day or one trap to every 70 persons resident in the village. Careful records were kept of the number of traps set each day and the number of rats caught. In Table II on page 38 some figures in this connection are given.

In the first column of the table the total number of rats caught each fortnight in the village is recorded, in the second column the number of traps set to capture this number is noted. In the third column, calculated from the two figures just mentioned, the number of rats caught per 100 traps set is given. Operations were begun towards the end of November 1905 and were closed in the beginning of November 1906. It will be observed that persistent trapping reduced the number of rats caught from 70 per 100 traps set during the first fortnight to 17 per 100 traps set during the last fortnight. If these figures can legitimately be used to give any idea of the extent of the rat population, it would appear that the rat population was reduced to one quarter of the original number. To effect this reduction, 11,390 traps were set and 2,603 rats were captured and destroyed.

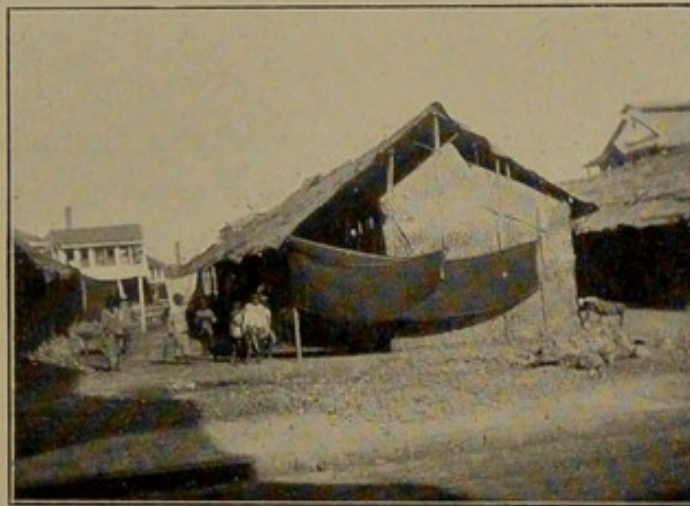
In certain other villages the Commission found that unless the number of traps set each day approached one to every fifty inhabitants, the rats multiplied as fast as they were removed. Any cessation of the operations was immediately followed by an increase in the rat population.

Judging from the experiments carried out by the Plague Commission in the village of Worli and in certain other villages, it would appear to be necessary to remove from a City like Bombay about $1\frac{1}{2}$ millions of rats within one year in order to reduce the rat population of that city to one quarter. To effect this, about 20,000 traps would have to be set each day, and a special staff of about 1,000 men engaged to work the traps. To begin with about 14,000 rats a day would require to be caught and after a year's operations about 4,000 rats each day. Any cessation of the operations would be followed by a rapid multiplication of the rats, the majority of these rats would be young and therefore susceptible to plague, so that the epidemic would be proportionately severe.

Evacuation.

In default of effecting any reduction in the number of rats present in a place, it is possible to prevent the development of plague in man by minimising the access of rats to him, for example by avoiding or vacating places where especially plague sick rats have been found. In view of the fact that man only becomes infected by plague after rats have died of the disease, and that the rat fleas only convey plague to man when from hunger they are driven to feed upon him, it is often possible to escape infection if the places in which dead rats have been found are vacated *immediately* after the rats have died. The Commission, however, have frequently observed that it is often extremely difficult to find the dead bodies of rats even although they have been carefully searched for in houses which were known to be infected and where it was possible to demonstrate the presence of infected rat fleas. Rats frequently, one might almost say generally, die in inaccessible places, so that plague may exist among a community of rats, though none of them may have been seen

dead. Moreover, rats may die from other causes than the plague. At the present time in India, however, to find a dead rat in a house is very often an indication that plague has developed among the rats in a building, and it is a safe measure to at once vacate such a building. But further difficulties soon arise, and we are confronted with such questions as where shall I go to? When may I return? Matters become worse when house after house becomes infected in a village or town. It has been the practice in India to evacuate a whole village when it is known that plague is epidemic in it. This is no small undertaking, and unfortunately is associated with considerable difficulties and danger. Evacuation involves some hardships, discomfort and expense.



A Health Camp.

Here is a picture of a so-called "Health Camp" where the evicted persons have to reside. It cannot be comfortable to live in such circumstances even when the weather is fine, but when it is wet, life in such surroundings must be almost unbearable. Evacuation, too, suffers from one great disadvantage, it affords increased opportunities for spreading the disease. Man is an important agent in carrying infection from infected places to healthy areas. Now, when evacuation is practised, this means of spreading the disease comes into full play, for many prefer to live with friends in uninfected places rather than submit to the discomforts of camp life.

Evacuation also tends to convert the fear occasioned by the high mortality associated with the disease into a panic, the people flee in all directions, and thus the disease is spread far and wide. I need only recall to your memory the panic and flight associated with the commencement of the epidemic in Bombay and how rapidly the disease was spread in this way.

Finally, evacuation is unsuitable for towns, not only because of the difficulty of finding adequate space for the camps, but also because the measure, as a rule, cannot be resorted to early enough. It has already been pointed out that a place may be infected although no dead rats have been found in it, and it should be remembered that to vacate a house after a human death has occurred in it is in the majority of instances quite useless.

When evacuation is not practised, the Commission found that only 20 to 30 per cent. of houses have more than one plague patient in them. Moreover, when two or more cases occur in the same house, the patients are generally attacked simultaneously. In towns, too, persons often acquire their infection at their place of work, not in their homes. In Parel village, a portion of Bombay City, the Commission found that more than 60 per cent. of the patients were infected at their place of work.

I may sum up what has been said about evacuation by pointing out that it is an efficient measure for preventing the development of plague among men, provided the measure is adopted early enough, that is, before or immediately after rats have been found dead in a house; but it is a dangerous measure when it encourages those who have been living in the midst of infected surroundings to seek refuge in healthy towns and villages in order to avoid the discomforts of a camp life. There can be no doubt that the saving of life effected by evacuating a village is often counterbalanced by the danger which exists of spreading the disease to uninfected areas.



Inoculation.

Fortunately science has placed in our hands a means by which we may defy the ravages of the disease. We can be protected from the disease by being inoculated with anti-plague vaccine. This means of acquiring immunity to the disease has generally been called in India—Inoculation. It has the advantage of being a measure of personal prophylaxis which can be carried out easily and cheaply, and it matters little who else does or does not co-operate in the measure. This is a great advantage in a country like India. The inoculated acquire a high degree of protection, and the mortality from the disease among them has been shown to be about one-sixth of that of the uninoculated under the same conditions.

The following statistics are selected not because they demonstrate the best results obtained by inoculation, but because in each instance they have been very carefully examined ; the records in every case having been accurately kept.

A very virulent epidemic of plague was raging in the village of Undhera in the Baroda State. The village was visited and a nominal roll of all the inhabitants then living in each household was made, and as nearly as possible one-half of the members of each household were inoculated. It was found that there were 950 persons then alive in the village, and of these 513 were there and then inoculated. No selection was made other than that required to make the inoculated and uninoculated groups as similar as possible as far as age, sex, and physical fitness was concerned. Plague continued in the village for 42 days after the inoculations were performed. The disease occurred in the houses occupied by 28 families. These families were composed of 71 inoculated and 64 not inoculated persons. The 71 inoculated had 8 attacks with 3 deaths, while the 64 not inoculated had 27 attacks with 26 deaths. We may infer that in this single village no less than 26 lives were saved by inoculation.

In the Punjab a large number of people have been inoculated. Major Wilkinson, late Chief Plague Medical Officer, has given us the figures referring to villages in which more than 10 per cent. of the inhabitants were inoculated four months or less before plague occurred in them. In these villages there were 186,797 inoculated as compared with 639,630 uninoculated persons. Among the inoculated there were 314 deaths from plague. Among the uninoculated there were 29,723. From these figures it is easy to calculate that nearly 8,000 lives were saved in these villages by inoculation.

Quite as good, if not better, results have been obtained in Bombay City.

In a chawl near Pilot Bunder inoculation was carried out two months before plague broke out in it. 61 persons lived in this chawl, and of these 24 had been inoculated. Only one of the 24 was attacked by plague and he recovered, while of the 37 uninoculated, 19 were attacked by the disease and 12 of them died. In this single building 12 lives were saved by inoculation.

Dr. Turner and his staff inoculated a large number of the Municipal servants living in certain Municipal chawls, with the following results :—3,317 were inoculated, while only 838 remained uninoculated. Among the large number of inoculated there were 3 deaths from plague, while among the small number of uninoculated there were 18. 60 lives were saved by inoculation.

In Karachi a similar saving of life was effected. 1,245 inoculated had 4 deaths while 60 uninoculated had 5. It is easy to calculate that 100 lives were saved by inoculation.

Among the Police in Khandesh great saving of life was effected by inoculation. 1,508 inoculated policemen had 3 deaths from plague, while of 230 uninoculated 4 died. 23 lives were saved.

Railway Companies have had a like experience. The Southern Mahratta Railway Company had 1,260 of their hands inoculated in Hubli, and 760 living in the same places refused to be done. The former had 2 deaths among them, while the latter had 21. Inoculation in this case saved 33 lives.

Millowners can confirm the advantages of inoculation. Mr. Bazonji Dadabhoy, Manager of the Empress Mills at Nagpur, found that 1,116 inoculated mill hands had 6 deaths from plague among them, while 2,663 uninoculated mill hands had 179 deaths from plague. Sixty-nine lives were saved by inoculation in this case.

So much then for the value of the protection afforded by inoculation. Although inoculation cannot eradicate plague from a country or district, nevertheless every case which is saved from the disease is so much gain and, moreover, affords less opportunities for the spreading of infection by friends who would have come from other towns and villages to attend the funeral ceremonies. These friends may acquire plague, and on return to their homes often transmit infection to uninfected localities.

Inoculation, too, has the great advantage of instilling into those who undergo the operation that confidence which is so necessary to avert a panic. When the majority in a village are inoculated, the epidemic assumes such moderate proportions that it can be dealt with easily, nor is it difficult to adopt measures to prevent the spread of infection to adjoining areas.

Measures of Temporary Utility.

Rat destruction, evacuation and inoculation are measures of temporary utility and contrast in this respect with the measures of permanent utility already enumerated. They are measures which can be put into immediate operation to effect a large saving of life, while the more permanent, radical, and slow measures of reform adverted to above are being developed. They are all measures that require to be repeatedly carried out, and in this respect rat destruction and evacuation possess no advantage over inoculation. While, however, the first two measures can be carried out by the people themselves, the latter requires the employment of a special staff of trained operators.

No single antiplague measure should be adopted to the exclusion of others, each has its advantages. On the one hand inoculation can best be practised when the danger from plague infection is imminent, a time when rat destruction would be of little use. On the other hand rat destruction can most advantageously be carried out in anticipation of a possible epidemic of plague in a village, that is, especially during the "off-plague" season. Evacuation is a useful adjunct to inoculation.



TABLE I. — *Bombay, 1905-06.*

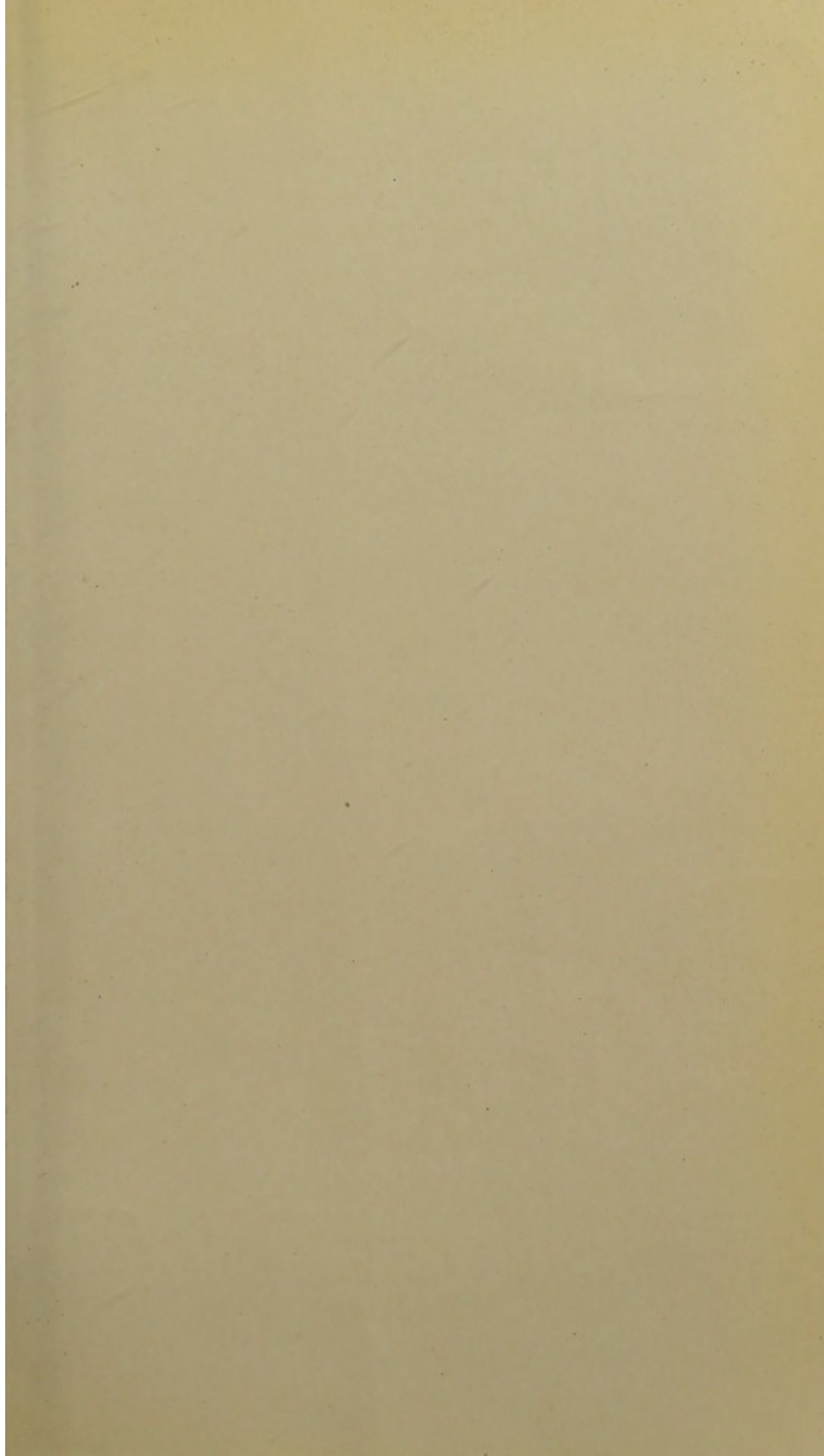
Statement showing percentage above and below the mean of Plague-infected decumanus, rattus and Human Plague deaths from 1st October 1905 to 29th September 1906.

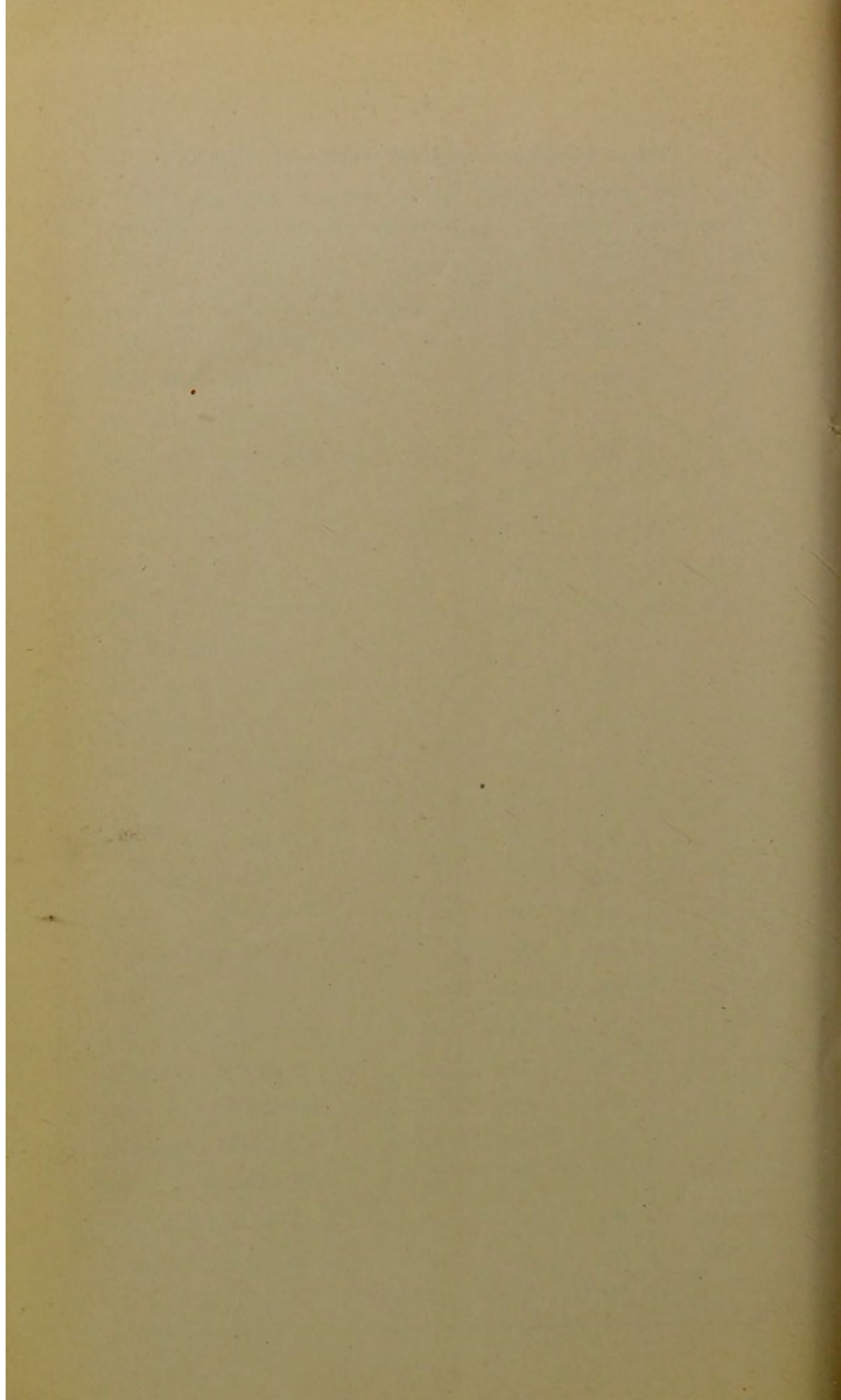
Weekly periods.		Per cent. above and below mean of plague-infected decumanus.	Per cent. above and below mean of plague-infected rattus.	Per cent. above and below mean human plague deaths.
1st Oct. to	7th Oct. 1905	... - 94	- 94	- 82
8th "	14th "	... - 93	- 94	- 89
15th "	21st "	... - 92	- 91	- 93
22nd "	28th "	... - 94	- 96	- 94
29th "	4th Nov. 1905	... - 90	- 94	- 92
5th Nov. "	11th "	... - 93	- 97	- 96
12th "	18th "	... - 87	- 93	- 94
19th "	25th "	... - 85	- 94	- 97
26th "	2nd Dec. 1905	... - 79	- 90	- 94
3rd Dec. "	9th "	... - 81	- 88	- 90
10th "	16th "	... - 75	- 90	- 95
17th "	23rd "	... - 70	- 93	- 95
24th "	30th "	... - 49	- 80	- 94
31st "	6th Jan. 1906	... - 23	- 72	- 93
7th Jan. "	13th "	... - 1	- 62	- 90
14th "	20th "	... + 70	- 4	- 86
21st "	27th "	... + 107	- 14	- 72
28th "	3rd Feb. 1906	... + 161	+ 46	- 71
4th Feb. "	10th "	... + 207	+ 98	- 48
11th "	17th "	... + 270	+ 176	- 29
18th "	24th "	... + 311	+ 156	+ 05
25th "	3rd Mar. 1906	... + 307	+ 221	+ 58
4th Mar. "	10th "	... + 284	+ 290	+ 118
11th "	17th "	... + 300	+ 308	+ 149
18th "	24th "	... + 260	+ 296	+ 263
25th "	31st "	... + 215	+ 208	+ 340
1st Apl. "	7th Apl. 1906	... + 112	+ 143	+ 296
8th "	14th "	... + 135	+ 214	+ 292
15th "	21st "	... + 115	+ 323	+ 391
22nd "	28th "	... + 34	+ 188	+ 422
29th "	5th May 1906	... - 22	+ 68	+ 383
6th May "	12th "	... - 46	+ 55	+ 226
13th "	19th "	... - 61	+ 19	+ 128
20th "	26th "	... - 71	- 48	+ 67
27th "	2nd June 1906	... - 76	- 46	- 8
3rd June "	9th "	... - 89	- 72	- 40
10th "	16th "	... - 88	- 88	- 63
17th "	23rd "	... - 88	- 82	- 71
24th "	30th "	... - 90	- 80	- 80
1st July "	7th July 1906	... - 90	- 85	- 84
8th "	14th "	... - 95	- 90	- 84
15th "	21st "	... - 92	- 85	- 86
22nd "	28th "	... - 89	- 90	- 85
29th "	4th Aug. 1906	... - 91	- 80	- 83
5th Aug. "	11th "	... - 88	- 83	- 90
12th "	18th "	... - 86	- 80	- 82
19th "	25th "	... - 89	- 80	- 91
26th "	1st Sept. 1906	... - 87	- 69	- 92
2nd Sept. "	8th "	... - 83	- 81	- 87
9th "	15th "	... - 88	- 64	- 87
16th "	22nd "	... - 85	- 69	- 87
23rd "	29th "	... - 89	- 79	- 83

TABLE II.—*Worli Village. Population 2,508.*

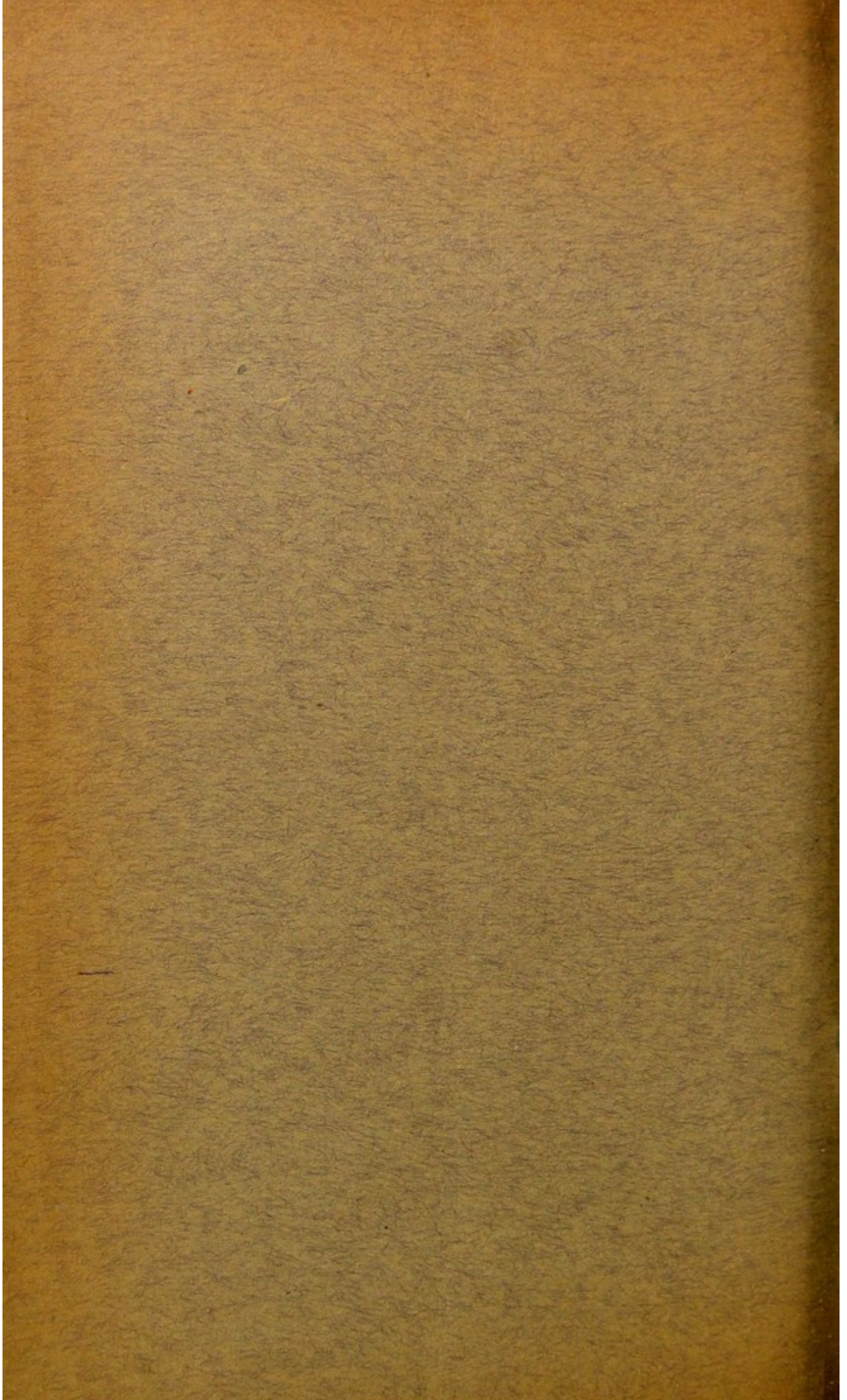
Table showing number of *M. Rattus* caught alive each fortnight from 22nd November 1905 to 1st November 1906.

Date.	<i>Rattus</i> caught.	Traps Set.	No of <i>Rat-</i> <i>tus</i> for 100 traps set.
22nd Nov.—3rd Dec. '05	370	526	70
4th Dec.—17th „	287	590	49
18th „ —31st „	199	577	35
1st Jan. —14th Jan. '06	215	684	31
15th „ —28th „	172	702	25
29th „ —11th Feb.	100	447	22
12th Feb. —25th „	86	537	16
26th „ —11th March	70	357	20
12th March —25th „	63	398	16
26th „ —8th April	53	267	20
9th April —22nd „	61	378	16
23rd „ —6th May	99	540	18
7th May —20th „	77	554	14
21st „ —3rd June	70	483	15
4th June —17th „	63	471	13
18th „ —1st July	89	472	19
2nd July —15th „	48	401	12
16th „ —29th „	46	480	10
30th „ —12th Aug.	53	308	17
13th Augt. —26th „	41	308	13
27th „ —9th Sept.	65	306	21
10th Sept. —23rd „	100	477	21
20th „ —7th Oct.	71	443	16
8th Oct. —21st „	42	308	14
22nd „ —1st Nov.	63	376	17
Total	2,603	11,390	









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19.

SOME PREVENTIVE MEASURES

ADOPTED IN THE

PRESIDENCY OF MADRAS

DURING THE LATE

EPIDEMIC PREVALENCE OF PLAGUE

IN INDIA.



BY

J. SPENCER LOW, M.B., CH.B., B.Sc.;

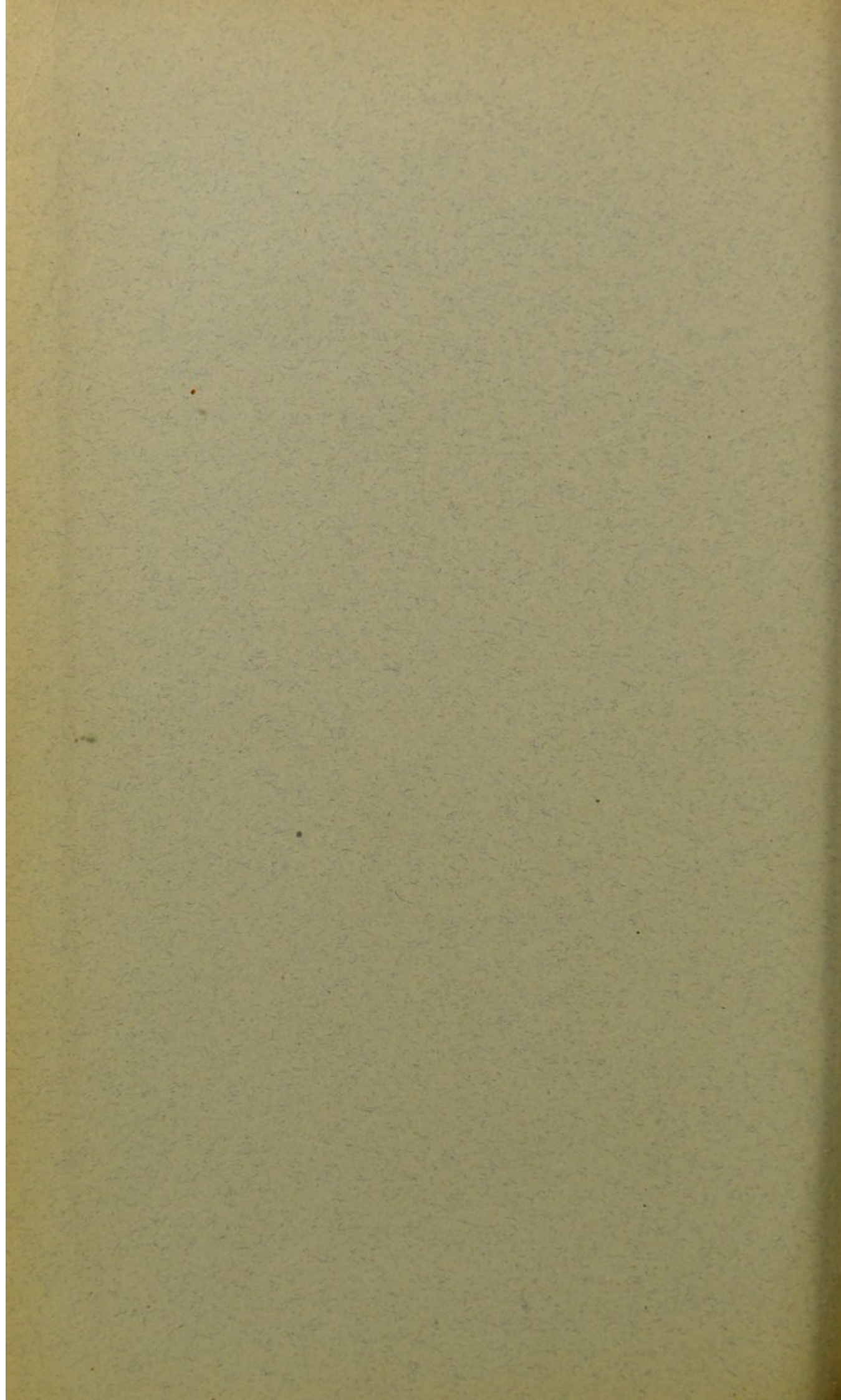
Assistant Medical Officer, Metropolitan Asylums Board, North-Eastern
Hospital; late Medical Officer of the Plague Camp and
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SOME PREVENTIVE MEASURES ADOPTED IN THE PRESIDENCY OF MADRAS

DURING THE LATE

EPIDEMIC PREVALENCE OF PLAGUE IN INDIA.

(Read: December 15th, 1899.)

THE Presidency of Madras, whether from its geographical position or as a result of the preventive measures adopted by its Government, has not suffered so severely from epidemics of plague as have some other parts of India. Though during 1897, 1898, and 1899 plague raged in one or another place on the frontiers of the Presidency, yet the number of cases which resulted from the repeated importation of infection was relatively by no means large. The Native States of Hyderabad and Mysore, both of which adjoin the western border of the Madras Presidency, are in constant communication with it by road and rail. In these two Native States, with a combined estimated population of about 17 millions, up to June 30th, 1899, 20,000 or more plague deaths occurred; while in the Madras Presidency the total number of plague deaths up to the same date in an estimated population of nearly 36 millions, was only 2092; and these were spread over no less than thirty-seven districts or municipalities, of which the city of Madras yielded only some eleven plague deaths.

Having had the advantage of being employed on plague duty in India during part of 1898 and 1899, I have thought it might prove of interest to this Society if I were to briefly sketch some of the plague preventive measures which were carried out in the Presidency of Madras.

Among the principal measures adopted by the Government of Madras, in their endeavours to prevent the spread of plague, were the following:—

- (1) The isolation of plague cases in plague hospitals.

- (2) The segregation of "contacts" in camps.
- (3) Evacuation and disinfection of infected houses.
- (4) Medical inspection and detention for observation of travellers by road and rail.
- (5) The passport system.
- (6) Inoculation by Haffkine's prophylactic.
- (7) The prosecution of measures of sanitary reform.

The following is a short description of these measures, most of which are closely associated with one another, especially medical inspection, detention of travellers, and the passport system.

(1) ISOLATION OF PLAGUE CASES IN PLAGUE HOSPITALS.

The house of the average native of India is no place for a case of infectious disease: not only on account of the ignorance of the attendants on the sick, but also on account of the invariable overcrowding of the house, and the almost universal absence of medical attendance, European or native. The "family" of a native includes not only his wife and children, but many other more or less near relatives.

At the commencement of an outbreak of plague in a locality, as long as the cases are few in number, removal to a well-conducted and equipped plague hospital is the best course of procedure. The patient is allowed, in India, to have two or three of his immediate relatives with him, who may nurse and treat him as they like, medical treatment by Europeans not being insisted upon if distasteful to the patient or his family. This course, coupled with evacuation of the infected house, and disinfection of it and its contents, is best calculated to prevent the spread of the disease. Were it possible to so treat all the early cases of an epidemic, the chances of arresting its further development would be great. But when the outbreak assumes such proportions that the hospitals are overcrowded, and numbers of moribund cases are removed there—possibly greatly against the wishes of patients' families—the people become terrified, and alarming rumours are spread broadcast among the natives as to what is supposed to go on in hospital.

The result of this is that plague cases are concealed, dead bodies are buried secretly under the floor of the house, or in the nearest convenient piece of ground; or the corpse is placed outside a neighbour's house, or thrown into his

well. If the segregation of contacts is actively enforced, the innocent neighbour is conducted to an observation camp, and made to undergo a period of observation, in spite of his indignant protests. The fear of segregation, as well as the fear of removal of the case, prompts the relatives to seek some method of concealing the illness; and in many places in India the authorities have been seriously hampered in their plague campaign owing to this concealment of cases.

Home segregation of plague cases under suitable and efficient supervision is calculated to combat these abuses, but it has to be very carefully applied. It has been found that no matter how simple these restrictions are, they are broken and evaded by all but the better-class natives.

By a process of education, in many places, such for example as Bangalore, the plague hospitals in course of time became less unpopular, and, except among Mohammedans, there was not much objection to removal of the patients to hospital. In Bangalore, home segregation was usually fatal to the patient, except among the better-class natives, and the restrictions were almost invariably violated.

(2) SEGREGATION OF "CONTACTS" IN CAMPS.

The segregation of "contacts" implies removal of such persons to observation camps, and their detention there for ten days, under medical supervision. Communication with the outer world is prevented by police or Sepoy guards. Within these camps the people are housed and fed for the prescribed period, and are examined daily by medical officers. In these camps, caste prejudices and the privacy of females are the two great sources of discontent and difficulty, and both have to be carefully respected and provided for. The Sanitary Commissioner of Madras, Lieut.-Col. W. G. King, I.M.S., holds the view that no "contacts" should be segregated if they can be trusted not to abscond. He would have them duly observed daily for ten days, under penalties for evasion. This opinion is not held by the Government of Madras. The value of segregation of contacts is doubted by the Bangalore authorities. They only succeeded in securing 2485 plague contacts in connection with nearly 6000 plague *deaths*. The number of plague *attacks* officially reported during this period was only some 4000, but as there was an excess of 5767 over the average num-

ber of deaths from August to December, 1898 (and at this time the ordinary population was much diminished on account of the exodus due to plague), when plague was at its height, and quite out of hand, it follows that there must have been many more than 4000 plague attacks. Although it is impossible to calculate the number of contacts owing to the number of attacks being unknown, it will be seen from the figures given, that only a relatively small number of contacts were secured. Out of these 2485 contacts, only 76, or 3.06 per cent., developed plague. The feeling stirred up by measures of segregation, and the comparatively small number of plague cases detected among these "contacts" seem to show that segregation, as employed in Bangalore, was a failure. Segregation can only do more good than harm when completely carried out. In the early cases, when there is a possibility of the disease being checked, and at the end of an epidemic, when the last remnants of infection must be stamped out, segregation doubtless is valuable. But when it terrifies the people, so that they flee from the bedside of their relative attacked by plague, and spread over the country, it would appear to be a mistake. Prompt disinfection, and daily inspection of "contacts" at their own homes, seem to be the only possible measures when the epidemic assumes formidable proportions. By this means the natives are not alarmed, neither would they scatter over the country: at any rate, to nothing like the extent they would otherwise do, if they knew that every "contact" would be forcibly removed to an observation camp.

At one time it was thought that the collection in camp of large bodies of people who have previously been exposed to plague infection, would involve danger of an outbreak of the disease in the camp, and would thus establish fresh foci for the dissemination of the disease. There does not seem to be much danger of this. In the Jalarpet observation camp, of which I was medical officer, some 11,500 persons were detained for observation, disinfection, or both. A large number of these people, all from infected areas, were detained for ten days. Among these were many suspicious cases, and about fifty who remained in the observation camp one or more days before being finally diagnosed as plague and sent to hospital. Some of these showed no symptoms for a few days after admission to the camp, but were clearly proved on investigation to have contracted the disease outside, finishing their incubation period in the observation camp. Suspicious cases were isolated in the

observation camp as far as possible, but in many cases this was merely nominal: for neither could the police guard nor the people in camp understand the danger, nor could they be prevented from mixing as soon as the medical officer or hospital assistant was out of the way.

Even under these circumstances, not a single case occurred which gave rise to any suspicion that the disease had been contracted in the observation camp. Theoretically, a "suspicion" camp might have been formed for such cases, but in practice there were no grounds for supposing that any infection had taken place, and this partial isolation seemed to be efficient. When a plague case was removed from the observation camp, the hut occupied by the patient was thoroughly disinfected with perchloride of mercury (1 in 1000), and whitewashed. It was then allowed to dry, exposed to the sun for a day or two, and then brought back into use.

Although most plague patients took two or three of their family to the plague camp with them, as attendants, none of these contracted the disease at Jalarpet; neither did any of the staff, which, inclusive of the police, numbered some 100 souls. Even in Bangalore, in one hospital only one native hospital assistant and a few menials were attacked, although 956 plague admissions took place in this particular hospital; and in another hospital 768 admissions took place without a single case among the staff.

In the Jalarpet plague camp, which was in a non-infected area, deriving its cases from passengers removed from trains arriving from infected areas, there were many rats in the plague hospital, which used to visit the neighbouring fields, and probably the little scattered villages a quarter of a mile off; no dead rats were ever seen about the fields or camps, nor were there any plague cases produced indigenously. Although infectious matter was present in the hospital, it was dealt with in such a way (by incineration and corrosive sublimate 1.—1000) that rats, so far as is known, were never infected. It may be of interest to note that patients in the plague camps used to be awakened in the night by rats running over them. Captain Leumann, I.M.S., holds that the bacilli of plague are only found in bloody urine, bloody sputum, and bloody faeces. If a case is recognised early, and the discharges from the patient efficiently dealt with, the infection of rats and the spread of plague by their agency would appear to be impossible.

(3) EVACUATION AND DISINFECTION OF INFECTED HOUSES.

Wherever a building became infected with plague, whether from the occurrence of an actual attack therein, or from the fact that dead rats, squirrels, or monkeys were found in the house or its vicinity, in many places the inhabitants were removed and segregated in temporary shelters for a week or two, the house being disinfected. The opportunity of compelling persons to vacate insanitary property was seized wherever possible, especially upon the occurrence of a plague case. The method of disinfection employed was to drench the walls and floors with mercuric chloride 1—1000. The disinfecting staff were directed to collect all excrement, sputum, &c., mix with some combustible material, and burn them. All rags, clothes, and bedding stained with the discharges of plague patients were similarly treated, compensation being given in some cases. Earth floors were dug up and walls were white-washed. Native patients have a habit of expectorating upon the walls of their rooms, or into the hands of relatives held up to form a spittoon. In this way infective discharge may be freely carried about the house and elsewhere.

In many places houses were unroofed, partially or completely, to admit sunlight and for free ventilation of the house after evacuation. It is of importance to remember that the chief haunt of rats in a native house is under the roof: hence the necessity of attacking completely this part of the house, as well as the lower rooms. Native houses are very badly ventilated, and in the houses of Mohammedans especially, the windows are stopped up with cloths to afford privacy for their women.

During the rainy season houses are disinfected, as above, but not unroofed, holes being made in the walls for ventilation.

Compensation was given to tenants where such damage was done to a house, as in untiling, that the man had to lay out funds to secure repair; but not where Government servants unroofed and subsequently re-tiled the house after a proper interval. In dealing with the houses of natives, the privacy of their home has to be respected. This is a great obstacle in evacuation, and the importance of evacuation has to be carefully instilled into the minds of the people. When properly put to them, it has been found that such difficulties

can usually be overcome, and evacuation is agreed to. Wherever there is a chance that evacuation may become necessary, it is well to try and get the people to build caste camps for themselves in the fields, so that when it does become necessary, all arrangements are made, and caste difficulties are averted. It is almost the universal experience to find that a plague epidemic ceases in a village after evacuation into huts in the fields. The sick are isolated apart, and the people live for a few weeks in the fields, until their houses have been disinfected and freely exposed to the sun and wind. During the first few days after evacuation, isolated cases occur, from previous infection, but these cease in a few days. Evacuation, however, is not universally practicable, depending for its efficiency upon (1) the *weather*: for during the rainy season, when the epidemic is usually at its height, camping out is impossible; (2) the *character, habits, and status* of the people—for an urban population have great objection to camping outside their town; and lastly (3) upon the *labour available* for building temporary structures for the people; because in times of plague the sanitary staff are overworked, and labour is difficult to get, unless the people themselves erect the shelters from material supplied by Government.

Some very satisfactory instances of the efficacy of evacuation are seen among troops. In Bangalore it was found necessary to carry out this measure in the case of a native regiment and the native followers of several British regiments and batteries. In all cases, further development of plague was arrested after evacuation except during the first few days. To take another Bangalore example: the suburb of Knoxpett, inhabited by a low-class population of 1700, was attacked; cases occurred persistently until the suburb was evacuated, only three cases occurring afterwards, all within the next five days. This is the general experience of evacuation.

(4) MEDICAL INSPECTION AND DETENTION OF TRAVELLERS.

(a) *By road.*

(b) *By rail.*

(a) *Road Inspection.*—Road frontier inspection stations are maintained on main roads running from an infected to a non-infected area. Behind the inspection station are two rows of observation circles, each of five miles radius, and each under the charge of a plague sanitary inspector, whose duty is to patrol his circle systematically, in order to gain early

information of a case of plague, to check the possession of passports, and to keep a record of all persons suffering from fever continuous for more than twelve hours. All persons entering a non-infected district from an infected area are inspected by a hospital assistant at the road inspection station, and are detained there for observation if they are judged to be suspicious of plague. These are kept under observation at the station, and the nearest medical officer sent for. Those persons who are not suspected of plague are given a passport which binds them to appear daily for ten days before the local authority at their destination. Travellers who do not seem likely to observe the rules under which they would be allowed to proceed freely under passport, complete a ten days' observation at the inspection station. It will be seen, therefore, that the system of medical inspection and detention of travellers is intimately associated with the passport system.

The utility of an inspection station, whether on road or rail, depends almost entirely upon whether every person passing through it is inspected or not. If it is a railway inspection station, it is comparatively simple to ensure the inspection of every passenger by locking the carriage doors, and refusing to allow persons to alight at stations short of the inspection station, unless they can show some proper business at the place at which they attempt to alight. But the justification for the existence of a road-inspection station must depend chiefly upon its topographical position. In hilly parts, it will be found that roads from one district into another tend to go through passes bounded by rocks, jungles; forests or rivers. Under such circumstances, the traveller wishing to avoid an inspection station finds it a difficult and often dangerous matter to leave the road. For instance: the road between the Mysore State and the district of Malabar is bounded by a belt of forest inhabited by wild beasts of different kinds. A river may be a source of strength in the rainy season, but fordable during the hot weather. Where travellers can leave the road, and avoid an inspection station by making a *détour* through jungle paths, the essential point of inspection of every traveller is done away with, and the existence of such a station is useless. Some of the road-inspection stations in the Presidency of Madras were situated in such places, and were useless; whereas others, better placed, did excellent work.

Intimation of the passage of travellers was sent to their respective destinations to ensure their observation; and the

plague inspector in charge of the observation circle into which the traveller proceeded, supervised their observation.

(b) *Railway Inspection.*—Railway inspection stations are instituted at important points on the railways, not only in Madras, but in numerous other parts of India. The traveller from Bombay to Madras, a distance of some 900 miles, is inspected four or five times on the journey, and receives a passport* at a station a few miles outside the city of Madras, or wherever his destination may happen to be. Similarly, travellers from other plague centres, such as Bangalore and Mysore, are several times inspected on the way, and receive passports at their destinations.

It has to be mentioned that certain areas are declared "infected" by the Government of India. This list is changed from time to time, as plague leaves one locality or attacks another. It is, in relation to localities, upon this list that plague measures at railway stations are conducted.

Inspection stations are situated at convenient points between infected and non-infected areas. All passengers holding tickets from stations in these infected areas (such as, for example, the Mysore State, the whole of the Presidency of Bombay, the city of Calcutta, certain districts in the Presidency of Madras, and in the State of Hyderabad) have their tickets punched with a distinctive mark at railway inspection stations, after their medical inspection has been completed. On arrival at their destination, each passenger with a plague-punched ticket is given a passport, by the passport-issuing authority, which binds him to appear daily for observation for ten days. To further insure that each person from an infected area receives a passport at his destination, each passenger's name and address are taken at certain inspection stations, of which Jalarpet, where I was attached, is one. This "intimation slip" is sent on at once to the local authority at the passenger's destination, and the passports issued there are verified with the intimation slips. Of course there are many evasions, varying in the different districts from 3 to 10 per cent., but many of these are subsequently traced, and the evading passenger is prosecuted, when possible, under the Epidemic Diseases Act (India), 1897.

The procedure at a train inspection is as follows :

The train from the time it enters the station is under the absolute control of the plague authority, no one being allowed to approach or leave the train, until permitted to do so by the inspecting medical officer who is the plague

* For information as to passports, see p. 78.

authority. The carriage doors have in all cases been previously locked at the last stopping station, and police are posted on the off-side of the train to prevent surreptitious escape and evasion of inspection. The medical officer's duty is to satisfy himself that there is no case of plague in the train, and that no suspicious cases are permitted to proceed further on their journey. The suspicious cases, after detention and due observation for several days, while the diagnosis is settled one way or the other, are either allowed to proceed or are removed to the plague hospital, as the case may be. First and second-class passengers are examined in their carriages, their temperature being roughly taken by feeling the skin of the hand. They are put to practically no inconvenience. All third-class passengers are compelled to alight, carriage by carriage, the space before each carriage being roped in, and the passengers ranged around the rope in a single rank, with the women grouped at one end of the space for the nurse to examine. The medical officer then goes round the rope, feeling the skin of the arm of each passenger. In cases of a suspected rise in temperature the thermometer is employed, and if the suspicion of fever is confirmed, the person is conducted to a shelter on the platform for fuller examination.

The points which are regarded as of importance in the examination of railway passengers for plague purposes are as follows :

- (a) The temperature.
- (b) The gait and aspect of the patient.
- (c) The condition of the glands.
- (d) Other signs of the disease, as the condition of the tongue, and conjunctivae.

(a) The *temperature* is the point first noted, and if found at the medical inspection to be normal, the passenger is allowed to return to his carriage. Very rarely, cases with normal temperatures and discharging buboes of some standing are found, but their detection is more or less of an accident ; it would be almost impossible to examine all the glands of four or five hundred passengers in a train. The first step in the examination, therefore, is to observe the temperature, which in plague cases may range from slightly above normal at the very commencement of the attack, to 105 deg. Fahr. or more, in the case of a patient at the height of his attack.

(b) The *aspect and gait of the patient* are in many cases diagnostic. On walking, he lurches as if he were drunk; and if asked to stand still, his body sways in a very notice-

able manner. In cases not so markedly ill as this, great weakness and prostration is frequently displayed, the patient often fainting on examination. The staggering gait, weakness or prostration, with an increased temperature, with or without tenderness in the groin or axilla, are among the earliest manifestations of the disease.

(c) The *lymphatic glands* are next examined. The groins and axillæ are the commonest sites of buboes, then the neck; and among the rarer sites are the popliteal space and the bend of the elbow. Hard circumscribed swellings may be met with in the calf and in the middle of the back, one of which I saw in the back associated with an axillary bubo, went on to necrosis, the black necrotic mass separated, leaving a deep ulcer with hard undermined edges, which finally granulated up and healed. Buboes seemed, in my experience, to be single or multiple in about equal proportions. On examination, tenderness in the groin or axilla is a valuable sign, and precedes the formation of a bubo; this tenderness is followed by fulness, with some surrounding oedema, and then the bubo forms. The flexed attitude of a limb may give a hint as to the possible site of the bubo, which is very tender on palpation.

(d) *Other signs of plague*, all very common, are vomiting, diarrhoea, a coated tongue, red at the edges, frontal headache, mental dulness, pain in the back, and injection of the conjunctivæ, which is a valuable sign, the bloodshot eyes of the patient being very obvious to the most casual observer.

One of the great difficulties in conducting medical examination in natives, is their utter disregard for the truth. Whether they admit or deny having any symptom which the medical officer may mention, does not help him any further on in his investigation, unless this symptom is corroborated by some physical or other sign. One derives, therefore, no help from the patient, and any assistance he may offer may frequently prove to be merely put forward with a view to throw the examiner off the scent. Another difficulty is, that all questions put to the patient, in the great majority of instances, have to be put by an interpreter; and by the time the answer is delivered back to the examiner the answer he receives may have little to do with the question put, to say nothing of the time absorbed in the process. Even a knowledge of one native vernacular is not of much use in Madras, at any rate at Jalarpet; for frequently six or seven languages would be spoken by the different passengers in one train, though most had some acquaintance with Hindustani. Again, the physical con-

dition of the patient is always aggravated by the knowledge that he is being subjected to a more searching examination than his fellow-passengers; and this, if the patient is at all ill from any cause, may be sufficient to cause faintness and vomiting. There is a great fear of plague camps and plague officials among the natives.

During the ordinary routine medical examination of passengers, they are kept standing round the roped-in space in front of their carriage, until the examination of all is completed. The medical officer is followed round by clerks, who fill up the "intimation slip" of each passenger, already referred to. This sets forth the name, age, destination, address, and railway-ticket number, and is taken in duplicate by means of carbon-paper: one copy being retained for reference, and the other sent on to the passporting authority at the passenger's destination.

As each carriage is examined by the medical inspector, he detains a varying number on suspicion of plague: for disinfection if dirty, or for observation if the medical officer judges that they are not to be depended upon to observe the passport rules, or if their addresses are, in his opinion, insufficient. Certain classes, as pilgrims and others traveling in parties, are especially detained, as they frequently are dirty, and not proceeding to any fixed place of residence. The remaining passengers are, after this examination, and intimation of their pending arrival secured, allowed to proceed upon their journey.

When a person is detained by reason of his fever, the filthiness of his person, or for other reason mentioned above, he is marched off to a roped-in space upon the platform, where his name, age, and address are taken (in case he absconds from the camp).

The detained batch of passengers are then marched off, under a police guard, to the disinfection camp. After disinfection, those who are merely detained for this purpose are liberated, and allowed to proceed on their journey, intimation of their departure being sent on their destination. The remainder are passed on to the observation camp to undergo observation, either for ten days or less, as judged necessary by the medical officer.

The legal powers of a Medical Inspector.—Considerable legal powers are invested in an inspecting medical officer. He may detain any train for as long as he thinks necessary for examination; he may require any person to alight and submit to examination as he (the medical officer) may direct, using such reasonable force as may

be necessary for this purpose, with the help of the police if required; he may detain any passenger in camp if he thinks there is suspicion of plague, or if there is a probability that he has recently suffered from plague, and so is in an infectious condition; or if he has been in recent contact with plague, or if he be judged to be otherwise "infectious," which is further defined to be anyone who is filthy, has filthy baggage, or anyone from an infected area. The medical officer may demand any particulars he thinks necessary from any passenger, such as his name, address, movements during the last fifteen days, or anything else he wishes; and the passenger is bound, under heavy penalties, to answer truly. If anyone is found to be travelling from an infected area, and is unable to satisfy the medical officer that he is proceeding to a fixed address, the passenger may be removed to the observation camp, and detained there for ten days, when he is permitted to depart if he shows no signs of plague. The penalty for any invasion or obstruction of the above regulations is, upon conviction, imprisonment with or without hard labour for a term not exceeding six months, or a fine not exceeding one thousand rupees, or both fine and imprisonment.

Every passenger is further bound to submit his railway ticket to the inspector, and to have it marked with the plague mark (for future passporting at his destination) if from an infected area. If he alights at a station short of an inspection station, whether his ticket is for that place or not, and if he appears to have done so to evade examination, or if he can show no competent business at that place, he is sent on, at his own expense, to the nearest inspection station by the station-master, or by the police, or plague official posted there for this purpose. This has been found to be a very necessary precaution to take, owing to the evasions, attempted or completed, in this way, so that native hospital assistants were posted at stations on each side of Jalarpet. Their duty was to question every person who alighted at such stations, and if their answers seem unsatisfactory, to send them on to Jalarpet. It is to be feared, however, that bribery entered somewhat into this arrangement; and that not only was merely a small sum necessary for the hospital assistant to be completely satisfied as to the justification of the passenger in alighting at that place, but also refusal of such a gift resulted in persons with legitimate business at that place being sent on to the inspection station. Be this as it may, some persons suffering plague, knowing that they could not

successfully pass the medical examination at Jalarpet, attempted to alight at adjoining stations, and were successfully detected and sent on, to be diagnosed as plague on inspection. Similarly, passengers, knowing of the futility of attempting to escape in this way, deferred their endeavour to escape until the train arrived at Jalarpet, when they were found hiding underneath the seats of the carriage suffering obviously from plague. It is of the greatest importance, therefore, to exercise supervision at stations adjacent to railway inspection stations; and this, coupled with the locking of all the carriage doors in the train at the previous stopping station, practically insures inspection of all passengers.

Disinfection of Railway Carriages.—Every carriage from which a plague case is removed is detached and disinfected at once under medical supervision. In the case of third-class carriages (which have no cushions, etc.), they are thoroughly washed with soft soap and lime-water. After an interval of two or three hours this is washed off with plain water, and the interior and exterior of the carriage is sprayed with a solution of—

Perchloride of mercury	.	.	oz. $\frac{1}{2}$
Hydrochloric acid	.	.	oz. 1
Water	.	.	gallons 3

This solution is directed into all the cracks and crevices, and the carriage is allowed to dry; when, after being left in the open air for forty-eight hours, it is afterwards brought again into use. In the case of first and second-class carriages, which afford greater facilities for harbouring the bacilli of plague, the cushions are burnt and the woodwork treated as above. The carriage is then re-painted and upholstered again.

Methods of attempted evasion of examination by railway passengers.—These methods are numerous, and in many instances highly ingenious.

The obvious question that first suggested itself to the subtile oriental mind was, why be inspected at all. Accordingly, tickets were purchased for stations short of the examining station, as has been already detailed, the passenger intending to proceed a few miles by road, and to rejoin the railway at some station beyond the inspecting station. I have already mentioned that this plan was defeated by posting plague officials at these stations, and exercising supervision over passengers who attempted to alight there. Others did not attempt to leave the station they illegiti-

mately alighted at, but had carried out the plan of booking to this station, itself not infected, from some highly-infected locality, and, by purchasing a fresh ticket, to pose as travellers from a healthy locality. This was frustrated by instructing the booking-clerk and the plague officer to see that such passengers' fresh tickets were endorsed "plague-rebooked." They were then received at Jalarpet by the medical officer, and suitably dealt with on their real merits. As has been already said, some passengers suffering from plague were found concealed under the seat of the carriage; and occasionally it was necessary for the medical officer to head a storming party of police to dislodge a refractory passenger who refused to alight, the police objecting to storm the position unless led by the medical officer.

Another plan was to obtain, presumably by purchase, a certificate from some native official that he, the passenger, was in good health, and that he was travelling from a non-infected village in an officially plague-infected area. Beyond the wording of the certificate there was no possible proof that this was so, and the certificate had to be disregarded. This applies solely to manuscript certificates; many produced official certificates, which were of course genuine.

To avoid detention at Jalarpet, a very common plan was to arrange that a telegram should be sent to the traveller the day before he intended to start his journey, saying: "Your wife (son, mother, etc., as would seem most appropriate) died to-day; come at once." (This same plan is employed by Sepoys, anxious to obtain leave, or an extension of leave.) Other passengers were found to be travelling with borrowed or bought inoculation certificates,* as shown by the non-correspondence between the left thumb of the passenger and its supposed imprint on the certificate. Some of these persons were prosecuted and convicted, the usual fine being ten rupees. Among the more legitimate methods of attempting to avoid detention at Jalarpet, was that of being inoculated the day before starting on the journey. It is known to the natives that the inoculated are granted the privileges of exemption from detention unless they are suspected of actual plague; or they are detained merely for disinfection; and they are not required to take out a passport. This plan for evasion frequently defeated itself, since the usual inoculation fever, which persists for a day or two, caused suspicion that plague might be developing. Others put on new clothes to travel in, and in other ways

* For information as to inoculation certificates, see p. 84.

made themselves clean and respectable-looking; while others got themselves officially disinfected by the local authorities at their starting-point, and obtained a certificate to that effect. These endeavours were, when possible, rewarded by allowing the passenger to proceed on his journey, unless suspicious symptoms of plague were present. There is no doubt that many evasions by the above-known—and probably by many unknown—ways were successful.

The number of railway passengers examined and detained.—It is impossible to give accurately the exact number of persons medically examined at the Jalarpet railway inspection station. In checking the numbers for one month, I found the daily average for this period was 830. The inspection station was opened on August 20th, 1898, and at first only trains from Bangalore were inspected; latterly, as plague spread, other trains were added to the list. From August 1898 to July 1899, when plague prevalence had practically ceased for the time within about one hundred miles of Jalarpet, the estimated number of persons examined was 225,000. The actual number of detentions during this period amounted in round numbers to 11,500. The actual number of persons removed from trains, and whose illness was diagnosed at the time or afterwards as bubonic plague, was only 66. The percentage of passengers detained was, therefore, 5.11; and out of nearly a quarter million persons examined, only .03 per cent. had plague; or of the 11,500 detained only .57 per cent. were infected.

These results may be tabulated as follows:—

Number of Passengers Examined.	Number Detained.	Number of Plague Cases.	Percentage of Passengers Detained.	Percentage of Plague among all Passengers.	Percentage of Plague among Detained Passengers.
225,000	11,500	66	5.11	.03	.57

The percentages expressed in this Table have to be corrected to some extent, for whereas all the detained persons were from infected areas, only some two-thirds of those examined came from such places. The percentage of plague cases among passengers from infected areas is estimated to be about .045, and the percentage of passengers detained from infected areas would be about 8 per cent. The number of actual plague cases discovered among the travellers is small when it is remembered that many of the passengers

came from Bangalore, and from the Kolar Gold Fields, where plague was raging with great severity among the coolies employed there.

The utility of train inspection.—Although only some 8 per cent. of those coming from infected areas were detained for observation or disinfection, these included a very considerable proportion of passengers from highly-infected places, in contradistinction to passengers from areas merely declared "infected" officially. It is against these specially infected places that plague measures by detention are chiefly directed. All dirty persons, and those who do not appear trustworthy, are detained in observation camps; those who are "suspicious," by reason of fever, etc., forming only a small proportion of detentions. It is probably sufficient to inspect and passport all persons from ordinary infected areas, but against these highly infected places stronger measures are desirable; and every person who does not seem trustworthy enough to be given a passport should be detained for observation for the usual period, and liberated on its completion.

On the question of disinfection of railway passengers, the principal at any rate is sound; but when we consider the method employed in the majority of disinfection stations in India, its utility is, I think, open to question. The usual procedure is to strip the passenger, and to give him a cloth to wrap round his loins. His clothes and luggage are then disinfected by steam, a thorough and satisfactory method. There are usually articles in his baggage that would not stand this disinfection, so are exposed to the sun for an hour or so. The passenger himself is conducted to a bathing-shed, and a gallon or so of corrosive sublimate (1—10,000) is poured over him as he squats on the ground, leaving much of his body untouched; and the momentary contact of the disinfecting fluid can do little if anything to the parts of the body it does succeed in reaching. The passenger then receives back his clothes, and he is considered to be disinfected. He, on discharge, proceeds on his journey in a carriage that has not been disinfected, his fellow-passengers are possibly contaminated, and his own skin and hair are practically in the same condition in which they were before the passenger was detained. The disinfection of railway rolling stock is an impossibility on the large scale, though carriages which have contained cases diagnosed as plague are thoroughly dealt with in the way previously described.

The sole good this disinfection does is to sterilise the

clothes of the passenger, and this is no doubt very beneficial; but it is unsatisfactory to leave his skin, his boxes, his fellow-passengers probably, and his railway compartment untouched. If the clothes of every passenger were disinfected, more could be put forward in its favour; but where only those which seem dirtiest are dealt with, the value of the disinfection as at present practised is doubtful, considering the expense and inconvenience it occasions.

As regards the value of train inspection as a plague measure, the instance of Bangalore may be quoted. Some time before plague reached Bangalore, all passengers entering the place by the several lines of railway serving it were medically inspected. Several seriously infected towns in the Bombay Presidency, such as Poona, Hubli, Dharwar, Belgaum and Sholapur, were connected with it by rail. Suspicious cases were detained for observation, and the remaining passengers were escorted to their homes by police, to be further observed there for ten days by the plague authorities: a system which is considered by the Bangalore authorities to be more satisfactory than that of passporting. Plague did attack Bangalore in spite of these precautions, and in the city and cantonments, with a population of 180,000 (including 15,000 of a military population, who were little attacked), caused upwards of 10,000 deaths between September 1898, and March 1899. It has been conclusively proved that Bangalore was infected by railway, though the city and cantonment—the former under the government of the Mysore State and the latter under British rule—were infected from different sources.

The first case that occurred in the cantonment was the servant of a railway superintendent, who had just returned with his master from Hubli.

The first cases that appeared in the city were on the day following the occurrence of the above-named case, all among coolies working in the railway trans-shipping goods sheds of the Southern Mahratta Railway, and the disease was confined to these coolies and their friends for some time. The first infected houses were closely grouped round these goods sheds. Though the method of conveyance of infection is doubtful—for it might be brought by railway passengers, infected clothes, goods, or rats—it would seem most probable that passenger traffic is to be absolved from the charge, seeing that none of the passenger staff were attacked, and all those who contracted the disease were engaged in the goods department.

There are many means of communication between the

city and cantonment, and many common interests. In due course, the cantonment became infected by the occurrence of a second plague case—the first indigenous case—six weeks later. The disease then spread, appearing in many places simultaneously in city and cantonment, and got completely out of hand.

From the above facts, it would appear that railway passengers did not bring plague to Bangalore; and that the infection started, in some way or other—possibly connected with rats—in the railway goods sheds and surrounding property.

Mr. Cadell, I.C.S., in reporting on this outbreak,* considers that if any lesson is to be learnt from the results of plague measures, it is that the disease cannot be kept out of a place by railway, and still less by road inspections. Practically, the sole advantage he sees that they secure, is to prevent persons afflicted with plague travelling about the country; and looking to the few cases he considers have been thus detected, he doubts whether these examinations, with their attendant expense and the inconvenience they occasion to the travelling public—not to mention the black-mail levied by subordinates—are worth maintaining.

However, the fact still remains that plague has not spread to any appreciable extent in the Madras Presidency, those districts which were infected being closely grouped round infected districts in Mysore, Bombay and Hyderabad, with ninety-nine ways of access to a district in Madras for every one way that could be guarded by any less means than a complete cordon. Wherever access was by railway alone, distance putting other ways out of court, the disease has never got a foothold, and the few cases that occurred have been at once detected and isolated. The sanitary condition of towns in Madras is not sufficient to explain this immunity, for they are little, if any, better than many plague-infected towns in other parts of India.

Train inspection must always be associated with road inspection, to obtain the fullest benefit of the inspection system, for it is useless to impose restrictions upon passengers by train, and to allow at the same time travellers to pass freely about the country by road. With efficient railway and road inspection, and complete passporting of travellers, detaining the suspicious and those who appear untrustworthy, plague can best be kept under control, as far as the carriage of infection by travellers goes. Road

* "Report on the Outbreak of Plague in Bangalore, 1898-99," by Mr. P. R. Cadell.

inspection in India has not been thorough ; the staff are in many places corruptible, and some of the posts are ill-chosen. It is almost impossible to make a complete examination of each traveller, though this could be much better done than it has been in the past. The inspection and passporting of railway passengers, on the other hand, has been on the whole well done, and has achieved much for the salvation of the Presidency of Madras. Without the further co-operation of the people it is doubtful whether we can do more than has been done, attending to the points noted, and insisting upon their strict observance.

(5) THE PASSPORT SYSTEM.

Every traveller from an infected area, who has not been already under surveillance in an observation camp, is given a passport on arrival at his destination. If a railway passenger, the passport issuing authority (who may be the station-master or a specially-appointed official), sees from the plague-punch on the ticket that the passenger comes from an infected area. The passenger then is given a passport binding him to appear daily for ten days at an appointed place, under a penalty, the maximum of which is imprisonment for six months and a fine of Rs. 1000. The passport, a copy of which is appended, contains particulars of the traveller's name, age, address, and so forth, and is signed by him. At the end of ten days it is received from the passport holder, and sent to the district plague office, where, from the dates and signatures of the examining officer, it is seen that the passenger has been regularly and duly observed. The issue of passports is further checked by the "intimation slips" taken at some railway inspection stations, and sent on to the traveller's destination. The number of persons who give false addresses, in the hope of escaping observation, varies from 3 to 10 per cent. in different districts. This was accurately checked for a period of three months in the Salem district of the Madras Presidency, and found to be 3.4 per cent.

The Bangalore authorities claim to have done away with the difficulty of untraceable persons, by escorting all native passengers who arrive there to their homes, under a police escort, these passengers being then observed daily for ten days.

The form of passport used in the city of Madras is appended, and this is used with slight modifications throughout the entire Presidency.

Passport No.	Original.	Duplicate.
<p>(To be retained by the officer issuing the passport.)</p> <ol style="list-style-type: none"> No. of passport. Date of issue. Name of traveller. Place of destination. When the duplicate of the passport sent, and to whom. <p>Initials of officer issuing passport.</p>	<p>(To be issued to a person arriving from a plague-infected locality, or any notified area, under Regulation 22 under the Epidemic Diseases Act published in the "Fort St. George Gazette," Part I-A, dated April 11, 1899, page 137.)</p> <ol style="list-style-type: none"> District. Station of issue. Date of arrival. Name of person. Father's name. Caste. Age. Whence coming. Destination and residence during the next ten days (give District, Taluk, Village, Street, and Number or Name of the house). <p>I declare the above information to be correct, and I do hereby bind myself to appear above mentioned person for inspection, daily, for a period of ten days from this</p> <p>Date Signature or mark of traveller.</p> <p>Declared and signed before me. Signature and designation of the officer issuing the passport.</p> <p>Date</p>	<p>(To be sent forthwith to the officer appointed to conduct the ten days' inspection.)</p> <ol style="list-style-type: none"> District. Station of issue. Date of arrival. Name of person. Father's name. Caste. Age. Whence coming. Destination and residence during the next ten days (give District, Taluk, Village, Street, and Number or Name of the house). <p>I declare the above information to be correct, and I do hereby bind myself to appear above mentioned person for inspection, daily, for a period of ten days from this date before</p> <p>Date Signature or mark of traveller.</p> <p>Declared and signed before me. Signature and designation of officer issuing the passport.</p> <p>Date</p>

(Reverse.)

C.

Instructions to the officers appointed to conduct the ten days' inspection.

1. The officer shall daily inspect the passenger, and initial the original passport in token of the inspection.

2. He shall daily ascertain from the passenger whether there is any sickness or death in the house in which he is or has been residing. If the passenger is found to exhibit any symptoms of plague, or if any sickness or death is reported in his house, or if the passenger does not appear for examination on any day, the fact should be immediately reported to the President or the Health Officer of the Municipality.

3. If the passenger intimates, or it is otherwise known, that he desires to leave Madras within the period of ten days, the particulars of his future residence should be obtained and the fact communicated without delay to the local authority of the place of the new residence. The officer before whom the passenger must present himself for inspection at the new place of residence should be entered in the passport. Intimation of departure to any Railway Station in the province of Mysore should be telegraphed to the—

(a) Assistant Surgeon on plague duty, Yesvantpur, when the destination is a station on the Mysore State Railway;

B.

Endorsement of the Inspecting Officer.

Date	Signature	Designation
1st day		
2nd "		
3rd "		
4th "		
5th "		
6th "		
7th "		
8th "		
9th "		
10th "		

Forwarded to the President, Municipal Commission, Madras, the passenger having been duly inspected.

Date _____
Signature and Designation of the
Examining Officer.

Regulation 22 under the Epidemic Diseases Act, published in the "Fort St. George Gazette," Part I-A, dated April 11, 1899, page 137.

City Regulation 22.—Every person arriving, or suspected of having arrived, from any place declared to be infected with plague, or from any place notified by His Excellency the Governor of Fort St. George in Council for the purposes of this regulation, shall, unless exempted under Regulation 21, be bound to appear at a place provided for the purpose, and obtain a passport binding him to present himself daily for inspection for a period of ten days before the officer

A.

(b) Residency Surgeon, Bangalore, when the destination is a station within Mysore Province on the Madras Railway.

4. The inspecting officer should maintain a register in the following form :—

- (1) Date of receipt of intimation.
- (2) Name of traveller.
- (3) From what infected area arriving.
- (4) Date of arrival of traveller.
- (5) Number, date and place of issue of passport.
- (6) How long kept under observation.
- (7) State of health of the traveller and other persons living in the house in which he is or has been residing.
- (8) Date of departure if occurring within ten days.
- (9) Destination.
- (10) Date of intimation of departure to the local authority of the place of destination.
- (11) Date of despatch of the passport to the President, Municipal Commission, Madras.

named in the passport, and he shall be bound so to present himself. On the expiry of ten days, the passport-holder shall deliver up his passport to the inspecting officer for transmission to the President, Municipal Commission, Madras. In case he has to leave Madras City within ten days from the date of his arrival, he shall forthwith give intimation to the inspecting officer, who shall report the fact to the local authority* of the new place of residence, and enter in the passport the name of the officer before whom the passenger must present himself at the new place of residence, and the passenger shall be bound to present himself accordingly.

Provided that, when it appears desirable, the President, Municipal Commission, Madras, or the Health Officer may, by endorsement on the passport, exempt any person from personal attendance and permit him to be inspected at his residence.

In the case of minors and incapacitated persons, the obligation to take out passports for them, to present them for daily inspection, to report truly their names and addresses, to intimate any changes in their residence, and to comply otherwise with the requirements of this regulation, shall vest in their legal guardians or persons in whose charge they travel, or who receive them at the railway station of destination.

N.B.—Any person disobeying or evading the above or any other Plague Regulation, or any order made in pursuance thereof, renders himself liable to prosecution for an offence punishable under section 188 of the Indian Penal Code, with imprisonment of either description for a term which may extend to six months, or fine which may extend to Rs. 1,000 or both.

* *Vide* Mufassal Regulation 17 (i), published in the *Fort St. George Gazette*, dated April 11, 1899, Part I-A, page 139.

(6) INOCULATION.

When the Presidency of Madras was first threatened by plague, the value of inoculation by Haffkine's prophylactic was not so generally accepted as it is now. The Government, in drawing up plague regulations, hoped that it would prove valuable, but expressed at the time a somewhat guarded opinion about it. Every facility was afforded, however, for inoculation, and inoculators were appointed who endeavoured to persuade the people to come forward. No person was inoculated without his express consent. In many native regiments, the British officers were publicly inoculated at the head of their regiments, to inspire confidence in their Sepoys, who generally followed to a man the excellent lead given them by their officers.

In many localities the people hung back until the outbreak assumed formidable proportions, and then came forward in large numbers. Inoculators were warned against operating upon persons suffering from fever, but many persons in a late stage of incubation, or even early in the stage of invasion, came forward and were inoculated, to be attacked by plague in a day or two.

The early symptoms following inoculation are sensations of chilliness, headache, increased pulse and temperature, and general feeling of malaise, after about six hours. These symptoms increase, and persist for two or three days. Vomiting and diarrhoea may occur, and though the temperature does not usually exceed 102° , in some cases it rises higher. The local signs are inflammatory infiltration, which causes great tenderness, but very rarely suppuration. There is occasional desquamation over the inflamed area. The local and general symptoms may be comparatively trivial or very severe. The usual health is regained in from four to eight days, but the local tenderness and swelling may persist some days later.

The following rare symptoms after inoculation may be quoted :

" Joint pains	" Loss of appetite
" Erythema	" Constipation
" Urticaria	" Mental excitement
" Anæmia	" Feeling of unrest
" Emaciation	" Confusion of ideas
" General weakness	" Clammy taste in the mouth
" Dry cough	" Sexual excitement

" Asthma and chronic eczematous conditions are said to be alleviated by inoculation.

“The following symptoms of plague have no representatives in those following inoculation :—

- “1. Enlargement of glands
- “2. Blebs and sloughs
- “3. Lobar pneumonia.”

Certain privileges are conferred upon holders of inoculation certificates, who are exempted from taking out passports, or from detention in an observation camp, unless suspected of suffering from plague. They have, however, to be examined, and may be detained for disinfection if they or their luggage are dirty, or otherwise in a condition that merits disinfection. Moreover, they have to evacuate their houses, as others have to do, should a case of plague occur in it.

It is a fairly common plan, as has been already stated, for a native to be inoculated a day or so before travelling; being under the impression that, if inoculated, his chance of detention would be small. An inoculation certificate, however, is only valid from the 10th day after the operation till it is six months' old. The freshly-inoculated person, therefore, finds himself not only with a certificate not yet valid, but with fever, the result of inoculation. It is the rule for all fever cases to be detained, until, after observation, the condition is diagnosed as not due to plague. The traveller who had recently undergone inoculation found himself invariably—much to his own surprise—detained in an observation camp.

A common method of evasion is to obtain an inoculation certificate by loan or purchase, and to attempt to pass it off as the certificate of the passenger. The value of the imprint of the left thumb-mark of the holder, taken at the time of inoculation by the operator, is very great; and by this means many attempted evasions of this nature were detected, and the offenders prosecuted and convicted.*

* The system of identification by thumb mark is largely used in India for Government pensioners and the like, and is an almost certain test of identity. The three great divisions of patterns of the skin of the distal phalanx of the finger are the *arch*, the *loop* and the *whorl*. These may point in various directions and may be modified in various ways, so that it is usually a simple matter to recognise the print as a true pattern of the thumb, the left one being always selected. The difficulties in the system are, that (1) the patterns of some coolies are much worn away by hard work and give bad imprints, and in many cases quite unrecognisable ones; (2) the thumb impression may be badly taken by the inoculator. It is generally unnecessary to take a print of the thumb to satisfy oneself that the traveller is the genuine holder of the certificate; but if in doubt it is merely a matter of two or three minutes to take an impression and then to compare it with that in the certificate, a lens being of considerable use for this purpose.

The following rules for inoculations have been drawn up by Major Bannerman, I.M.S. (G.O. ⁸⁷⁶/_P 12/6/99 Government of Madras, Local and Municipal).

1. A certificate may be granted after one full dose has been given, but the recipient should be recommended to return for a second inoculation after ten days.
2. The full dose should always be given at one time, unless for medical reasons it is considered advisable to divide it. If it is necessary to do this, a certificate should not be given until the equivalent of two full doses has been given. If, however, no undue reaction ensues after the first fractional dose has been taken, it is advisable to give the full dose at once on the second occasion, after which a certificate may be given.

The form of inoculation certificate approved by the Government of Madras is appended.

PLAGUE.

No. B 5544.

No. B 5544

INOCULATION



CERTIFICATE.

Name

CERTIFIED that

Father's name

father's name

resident of

Street
Village'

Street
Village

Town
Taluk'

Town
Taluk

District has been inoculated by me, and that his thumb-mark was at the time impressed before me.

Space for left
thumb-mark.

Signature
and
designation.

District

Dated

189 .

Date

Note.—Unless suffering from, or suspected to be suffering from plague, the holder of the certificate is exempted from segregation, from detention when travelling, and from ten days' observation under the passport rules. It does not, however, exempt him from liability to evacuate an infected house, except in the case where all the occupants of the house have been inoculated, or have his clothes disinfected when travelling. The certificate is valid for a period of six months.

Initials of operator

(7) THE PROSECUTION OF MEASURES OF SANITARY REFORM.

Plague, as is well known, is frequently found associated with grave insanitary conditions; it becomes, therefore, the duty of all sanitary authorities to make special efforts to remove all such conditions as are favourable to the spread of the disease.

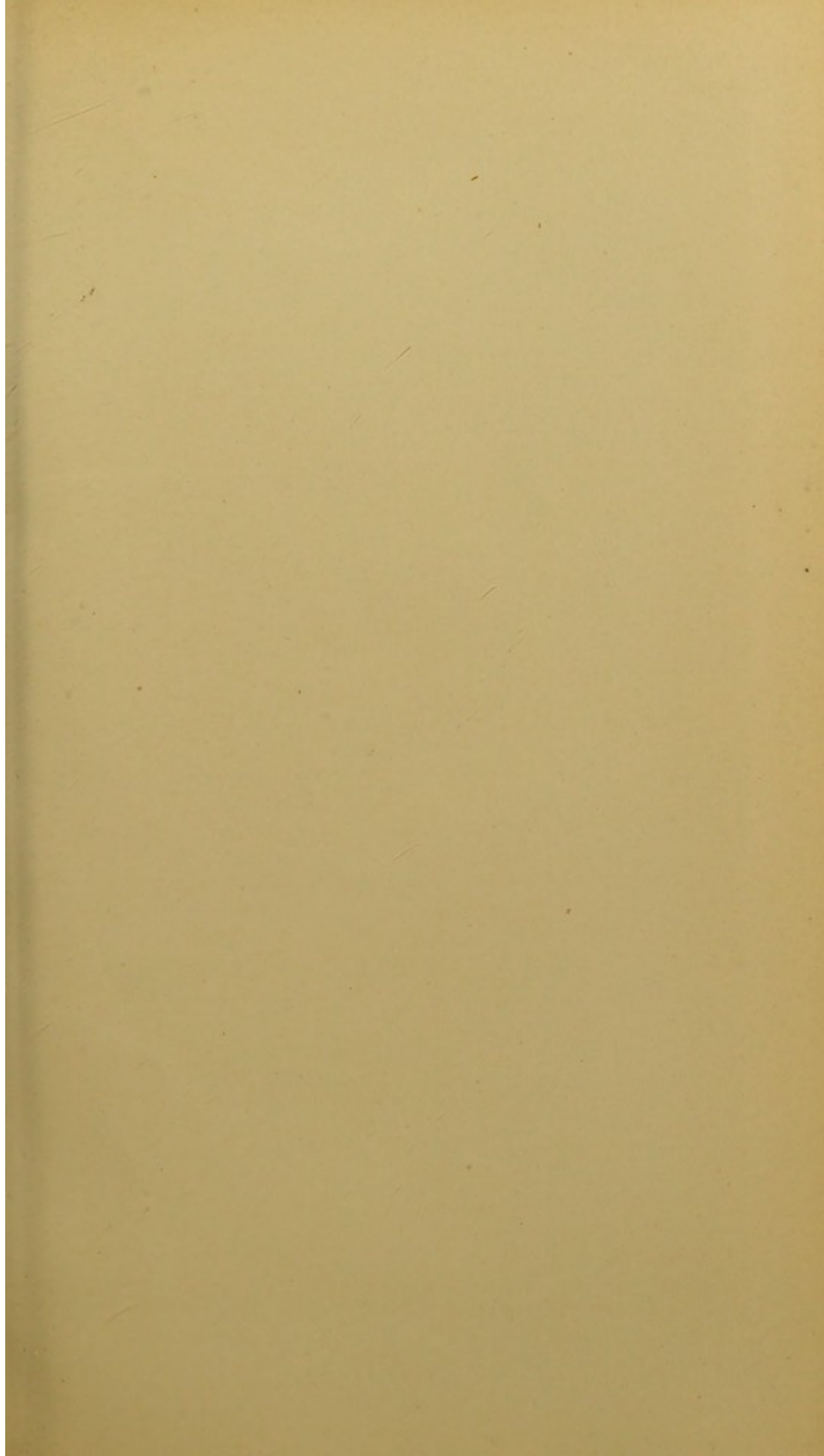
The abatement of nuisances such as accumulations of filth, and overcrowding, absence of light and ventilation, have all to be dealt with, and particularly dampness; the latter of which, according to Lieut.-Col. George Waters, I.M.S. (see *The Medical Magazine*, February and March, 1899), is the great factor in the spread of plague. Colonel Waters was in medical charge of two jails and a large school in the city of Bombay. The school, with 250 pupils, was situated in the midst of a severely plague-stricken area, and was the only institution of its kind to escape infection, except for two cases in 1896 and 1897. One of the jails was also kept dry and escaped infection. The other was so permeated with water from leaky pipes, as to defy all efforts towards the maintenance of dryness. Plague raged until the water was cut off. In six days the premises became dry and plague ceased, after the occurrence of thirty-four cases and seventeen deaths out of a jail population of three hundred. The disease did not decrease gradually, but suddenly, unlike the normal subsidence of a plague epidemic, for the last feature of the outbreak was six simultaneous seizures. Colonel Waters ascribes the immunity of Europeans as being mainly due to their dry environment. The above experience illustrates the importance of maintaining dryness.

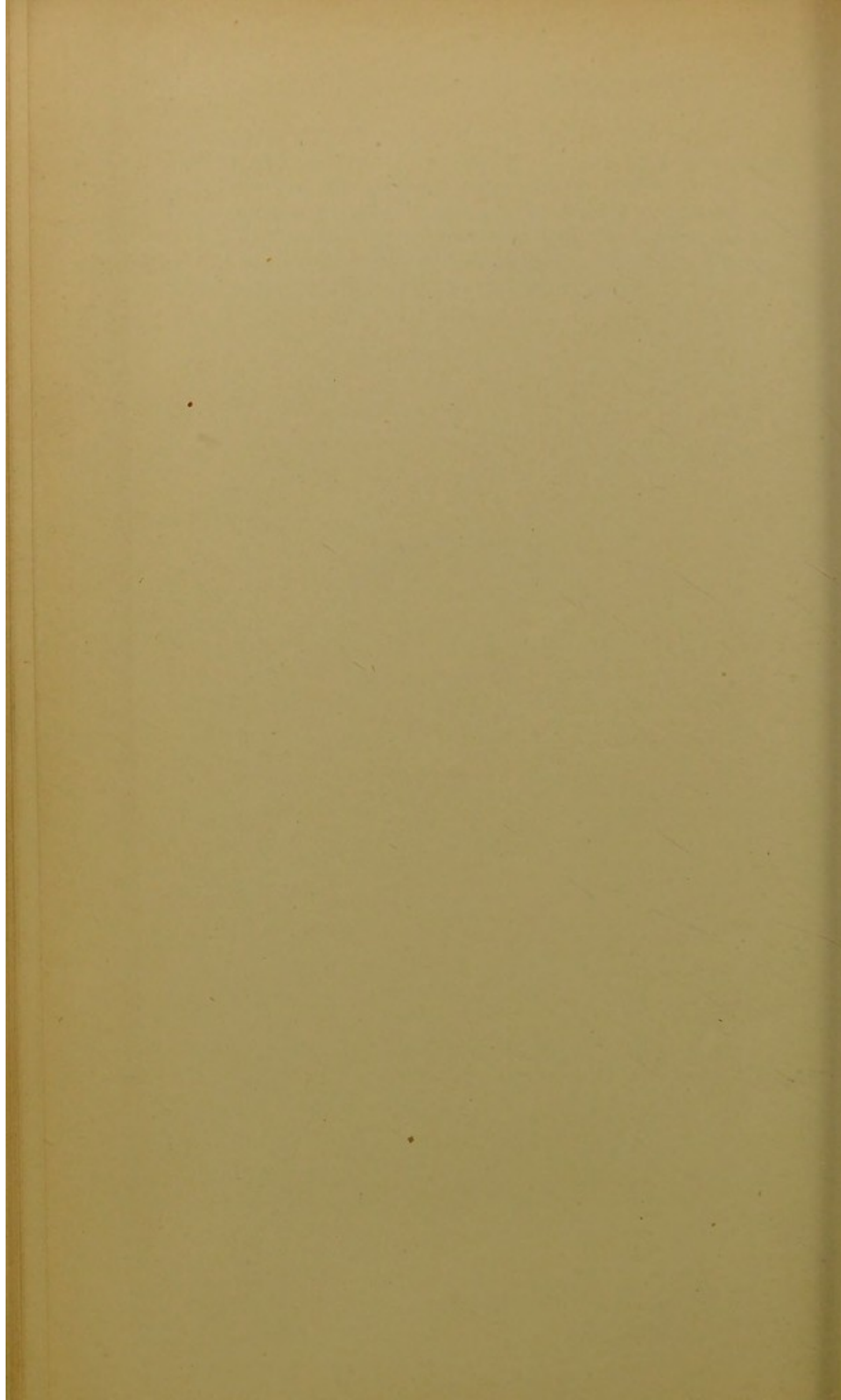
Returns of sickness and mortality have to be attended to. At present these are very inaccurately maintained, there being no general notification of infectious disease; registration, too, of deaths is very imperfect. The inspection of corpses is repugnant to the feelings of the Indian people, and is condemned by the Government of Madras, who doubt its practical value, though it has been largely practised in some parts of India during plague epidemics.

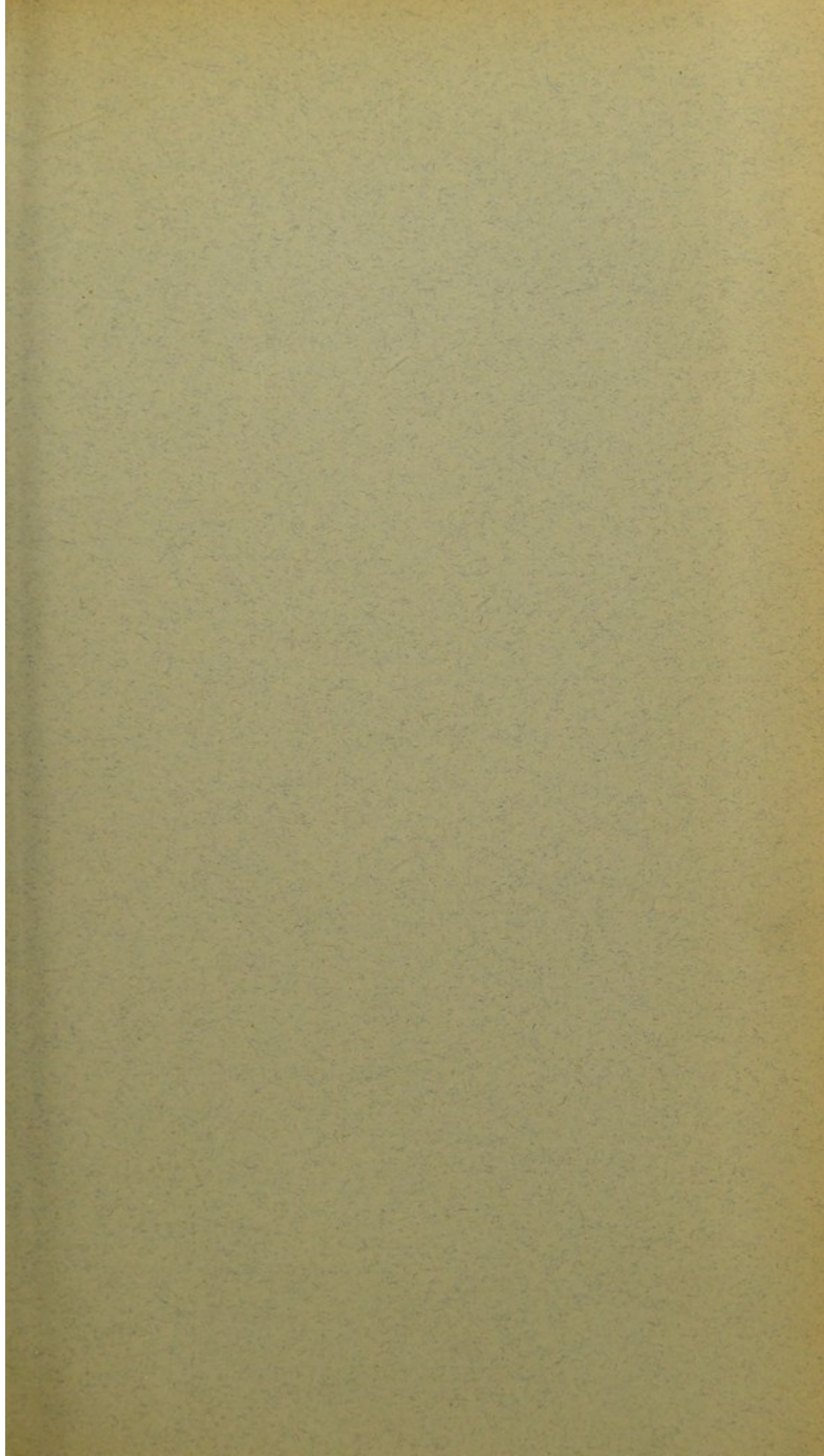
Until the public health organisation of India is put upon a proper footing, no great sanitary improvements or reforms can be expected. The majority of municipalities themselves cannot afford to adequately pay a health officer. Besides plague, there are other preventible diseases which

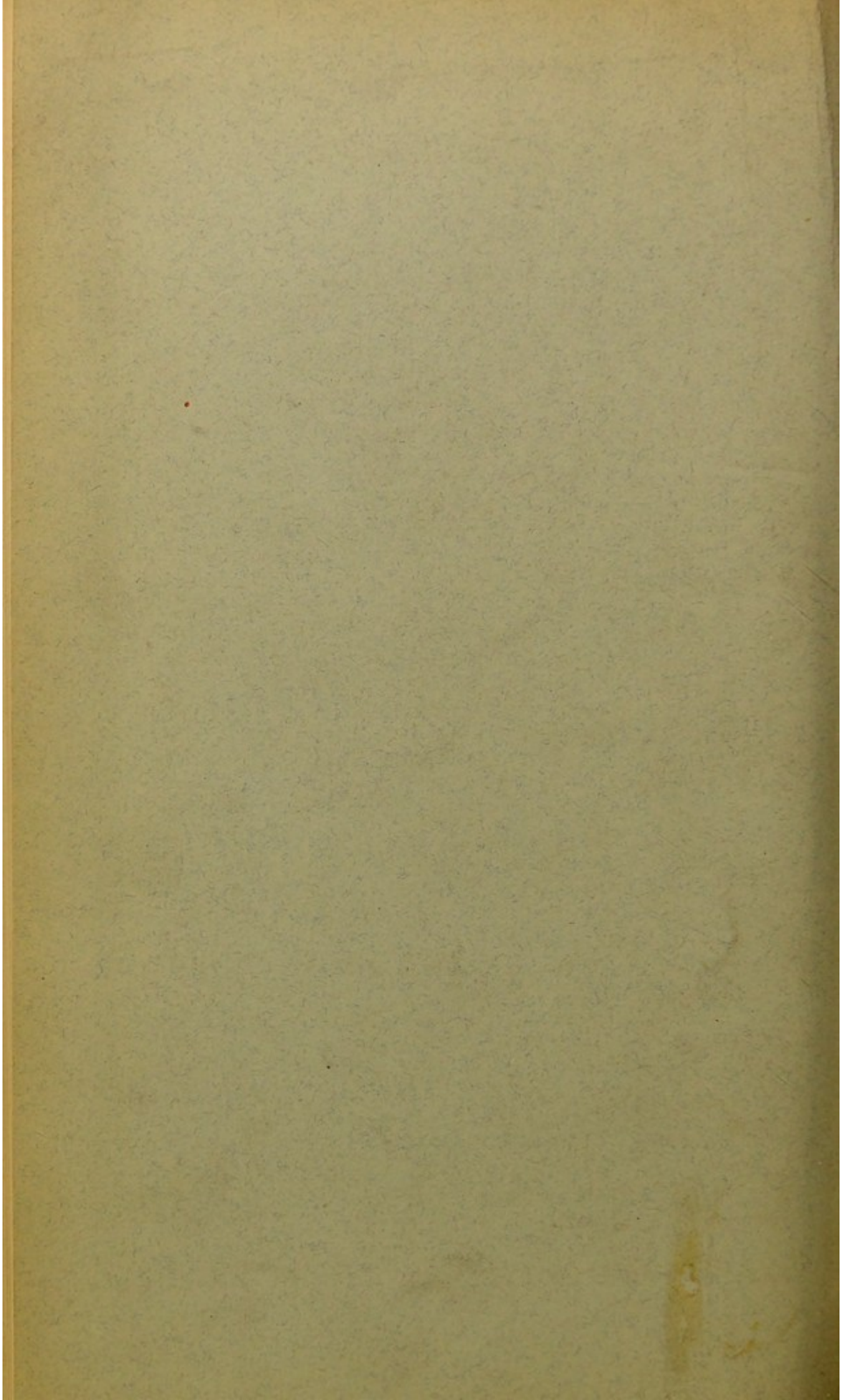
are causing a high mortality in India, and the need of trained sanitarians is everywhere great, and this urgent need deserves the earnest consideration of the Government. There are grounds for hoping that some recommendations in this direction may be contained in the report about to be issued by the Plague Commission, of which Professor T. R. Fraser, M.D., F.R.S., is the chairman.





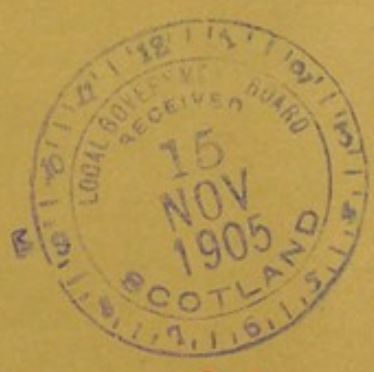






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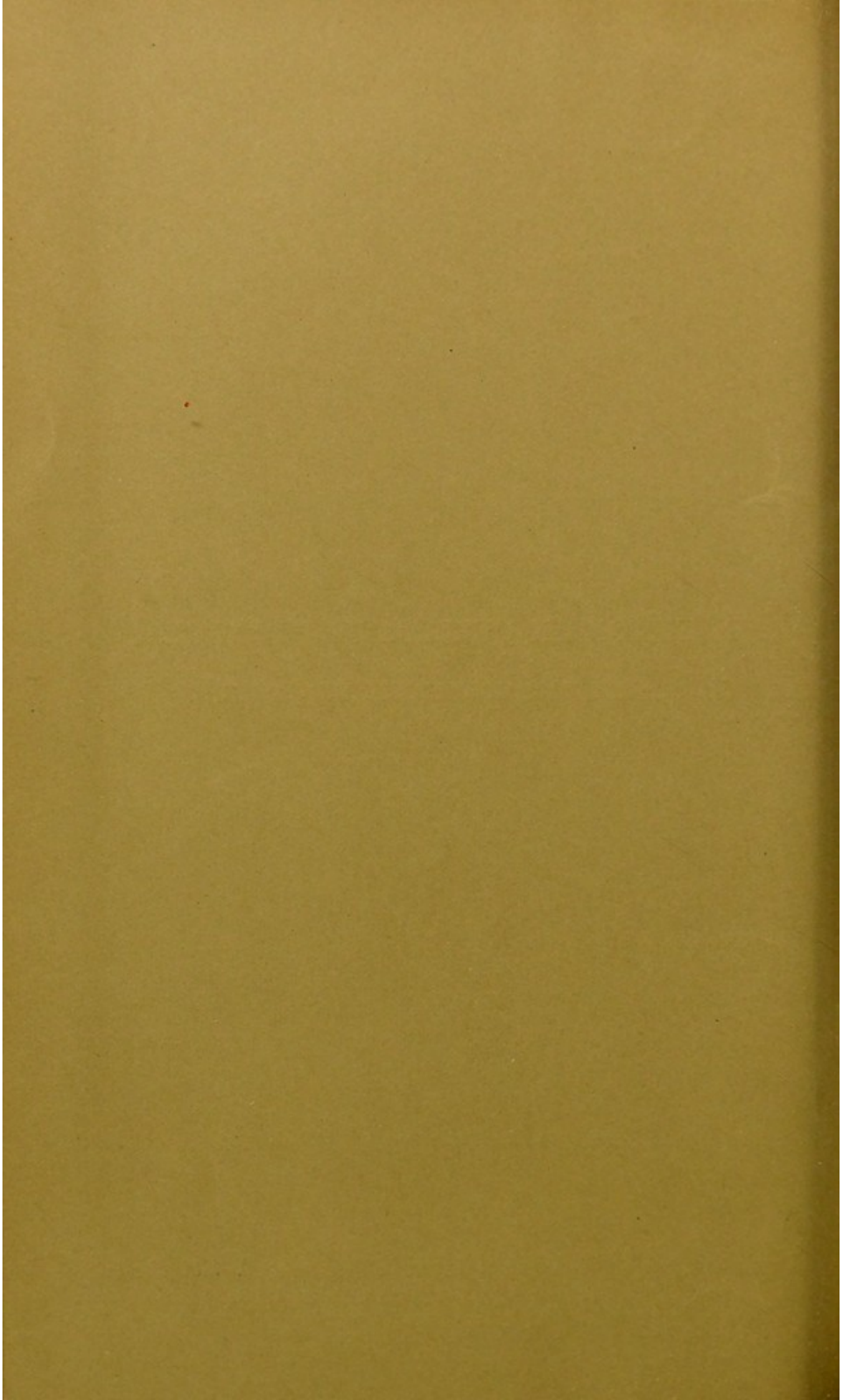


20.

NOTES ON AN OUTBREAK OF PLAGUE.

By WILLIAM ROBERTSON, M.D., D.P.H.

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NOTES ON AN OUTBREAK OF PLAGUE.

By WILLIAM ROBERTSON, M.D., D.P.H., *Medical Officer of Health, Leith.*

THE outbreaks of plague in Glasgow are still fresh in our memories, and the recent visitation of the malady to Leith impresses us with the fact that, after all, the East and this country are intermittently bridged over by fleets of steam and sailing vessels, each of which is capable of establishing a focus of plague infection on our shores. The most recent importation of a case to Manchester is an apt illustration of this point. A steamer arrived at Hamburg, thence she went to Middlesborough, and from that port a member of the crew went to Manchester, where he sickened and died of plague, rats infected with plague being subsequently found on the steamer. That this country has escaped so well is indeed surprising, when one considers how enormous is the traffic between the ports of Britain and those of infected countries. During 1904 no fewer than 1,040,429 natives of India died of plague. Of these deaths, no fewer than 550,000 occurred in the province of Punjaub, possessing a population smaller than that of England. Plague exists in South Africa, South America, and China. It has visited Australian ports, Odessa, Oporto, Alexandria, Port Said, and other shipping centres. These facts indicate how the tentacles of infection have spread themselves. Though we are separated from endemic areas by thousands of miles, it will be excusable, I think, if I cull the following paragraph from Professor Simpson's recent and lucid treatise upon plague. Speaking of the possibilities of famine, war, or atmospheric causes giving rise to scarcity, Professor Simpson says: "It is because of these dangers that the plague in India, with its extensive area of infection, may at any time become a menace to Europe; for it possesses all the potentialities which, once developed, would give it those diffusive qualities that have characterised former pandemics. It has at present reached Kashmir, and is not far from the borders of Afghanistan. Should it attack and pass through the latter country, it then reaches the high road through which so many epidemics have entered Russia and Europe. There is always the possibility of the plague in India assuming the influenza type, and, should this ever occur, there is nothing to prevent a repetition of the ravages that plague committed in the sixth and fourteenth centuries."

These are distinctly ominous words, and, coming from such an authority, they impress one with their gravity. But one must not forget that the sanitation of the fourteenth and twentieth centuries cannot be held up for comparison. Public Health Acts

were not framed to deal with overcrowding, dirt, and disorder. Dark, ill-ventilated, back-to-back, tumble-down houses were not summarily dealt with, and filth diseases were common. Drainage systems had not been laid down, nor was the scavenging and cleansing of streets methodically supervised. And, above all, there were no specially trained officials devoting their undivided attention to sanitation. In a word, we need have little fear of the spread of plague in this country. Our battlements of sanitation are strong, and though we may wince at the presence of the pestilence in our midst, we can fortify ourselves with the reflection that, by enforcing rigorous sanitary measures, we can immediately draw a cordon round the limited centres of infection.

Bad sanitation and plague go hand in hand. This has been abundantly proved in India. Sir Thomas Fraser has laid special emphasis upon the influence of bad sanitation with the spread of plague in his independent report laid before the Indian Plague Commission. Professor Simpson cites numerous instances where, as soon as an infected native village was vacated in favour of a clean compound, the spread of infection ceased. Native hospital attendants in well-aired, clean wards have escaped infection, while their friends and relatives living among unwholesome surroundings have been stricken with plague. In the sixteenth and seventeenth centuries, reliance could not be placed upon co-operation from an intelligent population. Our citizens have now been educated to understand the full significance of such a dangerous encroachment as plague. My experience in Leith affords strong testimony in favour of present-day intelligence and common sense as accessories to rigorous sanitary strictures. The full significance of plague and its attendant dangers were quickly grasped by the inmates of the houses in the neighbourhood of the infected district. For over a week windows were kept fully open night and day, and no householder offered dissent to the burning of sulphur in his house in order to frighten away rats and to kill vermin. Panic was absent, and in its place there appeared to be suddenly instilled into the minds of the inhabitants a strong desire to practise sanitary reform, in order to ward off the possible chance of infection.

In India, as soon as a native village is visited by plague, the inhabitants bundle up and fly. The difficulties of dealing with disease under such circumstances must be enormous, and bordering upon the impossible.

Having laid special emphasis upon the slight danger of spread of infection in this country, the experience of Glasgow may be cited as a direct contradiction. It must, however, be kept in mind that eight cases of plague had occurred in Glasgow before the true nature of the disease was suspected to exist. A death took place, and a "wake" was held over the body. This formed an ideal focus for the spread of infection. In point of fact, that "wake" was the prelude to a series of over thirty cases of plague.

It was only when a suspected case of enteric fever was sent into the Fever Hospital that the ominous bubo was detected, its contents examined, and the seriousness of the situation revealed to the health authorities. Our experience in Leith was happily more fortunate. It is most significant, however, that, had the death of our first patient taken place in his own house rather than in hospital, the situation in Glasgow might have been repeated in Leith. A "wake" would undoubtedly have been held, and, knowing the contacts and relatives as I came to know them after their ten days' sojourn in the reception house, I dread to think of the possibilities of that "wake."

To come to the point, let me deal with the history of the Leith outbreak.

CASES.—On the 5th of June, a man, *æ*t. 43, employed by the Corporation as a street labourer, was sent to hospital, and notified to be suffering from enteric fever. The history was that he had been seized with sudden illness on the 4th, the day before admission; severe giddiness, headache, vomiting, and complete prostration being the leading features of the onset. He had been at work on the 3rd inst., but had for some time been drinking heavily. Confronted with that confusing element, it is not hard to understand why, despite his sudden collapse, the man's illness was suspected to be enteric. Reliance had also been placed upon the Diazzo reaction, which cannot, in the light of our present-day knowledge, be held to be a reliable diagnostic. After the patient had been in hospital for two days, it was realised that his illness must be some other than enteric. Typhus was suspected; his prostration, temperature, feeble pulse, and negative Widal lending strength to that view. Added to that, we knew that his wife worked in a rag store, and though the season was against the typhus theory, the possible chance of Aberdeen rags having harboured typhus infection was not lost sight of.

Aberdeen, it may be mentioned, is, like Glasgow and Leith, an important rag emporium. On the evening of the 7th, after the patient had been removed to a well-aired ward, a swelling was detected in his left groin. Such swellings have been found associated with typhus—scarcely, it is true—and a close examination of the wrists, ankles, and chest revealed a subcuticular mottling, with here and there petechial spots, scarcely typical of typhus. On his back there were numerous petechiæ, which one could best liken to inflamed flea-bites.

Next day, on the 8th, a little girl, *æ*t. 3, the daughter of our first patient, was also sent into hospital as a case of enteric fever. Two days before admission she had taken to bed, vomiting and fever being leading symptoms. Prior to that time she had been in perfect health. Coming from the same house, and with a history of quick onset, the typhus fever idea still prevailed, but when a bubo in her left Scarpa's triangle was detected, our worst suspicions were suddenly aroused. The swelling was about the size of a small walnut. It was tough, irregular, not very painful, and the overlying skin adherent. A hypodermic was thrust into the father's bubo, and the serum exuding from the seat of puncture collected in empty vaccine tubes. Examination of the fluid

revealed the unmistakable presence of the bipolar staining bacilli of plague. For verification, two tubes were sent to Dr. Buchanan, the Glasgow Municipal bacteriologist, whose experience with plague had been wide, and from him came a corroborative microscopic diagnosis of plague.

On the 9th the father looked very ill. He lay in bed with his thighs flexed up on the abdomen, this position being assumed by plague patients when suffering from inguinal buboes. His bubo had enormously increased in size. It was tense, brawny, and angry, and had it been an ordinary cellulitis would have called for immediate and free incision. The tissues over the left half of the abdominal wall were infiltrated, and bore the characteristic look of a deep cellulitis with the superadded feature of severe bruising of the skin, the discoloration being doubtless due to the rupture of many blood vessels induced by the sudden and rapid stretching of the skin. On the 10th the scrotum and penis were greatly swollen and dark, suggesting to one's mind the existence of urinary extravasation. The man was extremely restless, suffered great pain, and was collapsed. His pulse was thin and almost imperceptible. His speech was very thick, and his eyes injected; but his intellect remained perfectly clear. In point of fact, when Dr. Mowat, my resident, made his nightly ward visit at 1 A.M. on the 11th inst., the patient remarked that he felt perfectly well, yet half an hour later he died of heart failure.

It may be said that the course of the temperature is not always the best guide for prognosis. Fluctuating temperatures, according to Professor Simpson, may mean nothing. A sudden fall of temperature, with a collapsed condition of the patient, usually indicates a fatal issue. A fall of temperature between the sixth and seventh day is usually a favourable sign. In some cases the temperature remains uniformly low or even subnormal. This last feature was found associated with one of the Leith cases. Strange as it may read, cases are known where the illness merely leads to indisposition, with headache, giddiness, and a bubo in the neck, groin, or arm-pit. The patient is not confined to bed, but after a considerable lapse of time death may take place as a result of heart failure. This is mentioned to dissociate one's mind from what might be termed text-book symptoms of plague. Text-book symptoms cannot therefore be kept before one as infallible guides to plague or any other infectious disease. I have smallpox as another infectious disease in my mind when I say this.

After a great deal of coaxing, the friends consented to a post-mortem examination, at which the following results were discovered. The body was that of a well-nourished, muscular man. The left groin, scrotum, and penis were distended and discoloured. The swelling had reached the level of the ribs on the left side, and involved the greater part of the left abdominal surface. The inguinal glands when cut into were matted together and adhering to the surrounding tissues. These again were boggy and wet. From the inguinal glands plague organisms were culturally grown. The spleen was greatly enlarged, and from it Dr. Noël Paton and Dr. Buchanan recovered organisms pathogenic to mice. The lungs exhibited patchy basal consolidation. The kidneys were slightly enlarged.

The body was buried in a part of the cemetery where the grave could not be interfered with without the consent of the Medical Officer of Health. This precaution was scarcely necessary, however, since in the presence of putrefying matter plague organisms quickly disappear. It is not easy, for example, to recover plague bacilli from a suppurating bubo.

The child's condition led one to suppose that her illness was to end fatally. Especially was the pulse bad, being weak, rapid, and thin. One could best liken it to the pulse of a grave case of diphtheria. Under the influence of strophanthus and brandy, the child's pulse improved. The cheeks were covered with a hectic flush, the eyes being clear and glassy. When addressed, the child's face exhibited a remarkably startled look. This, as subsequent events proved, was a concomitant of the illness, since, on recovery, the little girl was apathetic and sluggish in her action and speech. When Dr. Chalmers of Glasgow saw this patient on the 11th, he anticipated a fatal termination, so prostrate did she appear as she lay in bed, her head flexed on her breast and the knees curled up on the abdomen. No spots or rash were detected anywhere on the body. The bubo had increased in size, and was as large as a Tangerine orange. The overlying skin was adherent and beginning to show redness. As events subsequently proved, the child recovered, and the bubo did not burst. When she was dismissed on the 15th of July, the bubo had disappeared, the only trace of it being a slight firmness of the tissues, the result of inflammatory matting.

As soon as the plague organisms had been discovered, a visit was paid to the infected tenement, which was situated in a densely populated part of the burgh. The tenement was of recent construction, and thoroughly modern in every way. There were three flats. That on the street level was composed of shops, the upper two flats consisting of two-roomed houses entering from open balconies. In point of fact, it was the very type of tenement which every Medical Officer of Health would specify were he asked to suggest houses for the artisan classes. The walls and floors were perfect, the lighting and ventilation excellent, and the sanitary conveniences attached to each house left nothing to be desired. It was the last place, in this country at least, where one would have expected plague to break out.

The infected house was on the second flat, and, like all the others, very clean. I found the wife of our first patient in bed, and being treated for a swelling in her left groin immediately below Poupart's ligament. Up till the 4th inst. she had been at work at a large rag store in Leith. On that date she fancied she had, whilst at work, twisted her leg. She experienced pain in walking, this being a characteristic symptom of onset in those affected by inguinal buboes. When I examined the patient, she was lying on her back, her thigh flexed on the abdomen; I noticed also that her face bore a peculiarly anxious expression. The bubo covered an area about the size of the palm of one's hand, and was very tender on palpation. This proved that the bubo had been present for some time. On account of the interference with collateral circulation, the superficial veins were enlarged below the swelling. The patient was three months advanced in pregnancy, and since the 4th inst. there had been a slight uterine discharge, which as the days went

past had been increasing in amount. This flux presaged abortion, which invariably follows an attack of plague. Her temperature was 102° F.

The remaining member of the family was a little boy, *æ*t. 9, who was, at the time of my visit, out at play. After waiting for him to be secured, I discovered that on the left side of his neck there was a distinct bubo, slightly tender on pressure. This boy had never shown any untoward symptoms of illness or discomfort. In the course of an hour these two patients were removed to the hospital, and placed beside the other two members of the family.

On the 17th inst. the mother's temperature rose to 105° F., with the accompaniment of severe backache and abdominal pains due to the expulsive efforts of the uterus. Her face was flushed and bedewed with perspiration. Early next morning she aborted, and next day her temperature fell to normal, where it remained until the date of her discharge from hospital. For a fortnight the skin overlying the bubo remained very soft, but by slow degrees absorption took place, and when discharged a thickening of the underlying tissues was the sole trace of the bubo. A very pronounced symptom in the mother's case was the marked thickness of her speech, suggestive of the dry tongue after a large dose of morphia. This thickness of speech persisted for a fortnight. All through her illness her intellect remained clear.

Though the thickness of speech associated with typhus can be likened to that occurring in plague cases, there remains the feature of clear intellect in plague which is foreign to typhus.

The course of the boy's illness was uneventful. His temperature never rose above normal. It was necessary, however, to incise his bubo, which followed the course of ruptured plague buboes in that it kept discharging for a very long time. He was admitted on the 10th June, and did not leave hospital till the 27th of August.

Treatment.—In the father's case this was purely tentative. Stimulation with brandy and strophanthus and strychnine were resorted to, and the bubo treated with hot fomentations. The bubo was not incised, because nothing was to be gained by the step. True, the man's intense agony might have been relieved, but one had to consider the risk to the nurses and attendants, since it had been proved that the exuding serum from the bubo teemed with plague organisms. The man died on the 11th inst., on the seventh day of his illness. Yersin serum was used for the three other cases, 40 c.c. being injected into the drainage area beneath each bubo.

Very conflicting accounts are given regarding the efficacy of serum therapy in plague. No good results have ever been secured in Hong Kong by the use of Yersin serum, and in the Kennedy Town Hospital, where they used Calmette serum, in ninety-four cases the mortality was 85 per cent.

It is just possible, however, that intravenous injection of serum might yield better results, just as the intravenous injection of antitoxin does in diphtheria. One must also be chary as to statistical results, since good figures after serum therapy may after all only be associated with a sequence of inguinal types of plague.

Septicæmic and pneumonic cases resist all manner of treatment.

That the intravenous injection of serum in bubonic plague may do good, is shown from the hospital results at Brisbane, where the mortality was only 17·2. In the preceding year, without the aid of serum, the mortality was 44 per cent. Again, in 1902, serum treatment gave a mortality of only 13 per cent. Reports appear to prove that serum therapy offers better results when administered to whites than to blacks. As a set off to that statement, one must bear in mind that the mortality among whites is much smaller than among black or yellow races. During the Glasgow outbreaks Yersin serum was used intravenously, and with apparently good results. In Leith the convalescence of the three patients had been established before serum was secured. (One result of the hypodermic injection was seen in the immediate reduction in the sizes of the buboes.

Dr. Mowat was injected with 20 c.c. as a prophylactic, first because it was indicated after his exposure to infection; and secondly, because the after effects are not so severe as those following the administration of Haffkine serum. The disadvantage of Yersin is that the immunity conferred is only for three weeks, whilst in the case of Haffkine it is claimed to last for much longer. Dr. Mowat was troubled with urticaria for a few days around the seat of puncture, and suffered from slight malaise and headache. That complete immunity is not conferred by Yersin, is proved by the fact that a member of the Glasgow sanitary staff developed plague after he had been immunised. His attack was, however, an extremely mild one.

The origin of the outbreak.—The actual origin of the outbreak will, I fear, remain shrouded in mystery. By a process of exclusion we arrive at the following facts:—The invaded house was to my mind a perfect one, as far as a working man's habitation goes. There were no possible entrances for rats. The cellars underneath the shops on the basement flat were proof against the encroachments of rats or vermin. The floors of all the houses were lifted, but no traces of dead rats or mice could be seen. There were many rats in the neighbourhood, which was close to the upper reaches of the harbour. Rats were caught in this district, but not one showed any traces of plague, nor had there been any mortality noticed among rats or mice in any part of Leith. The husband who died was a street labourer in no way exposed to plague infection. He was not an abstemious man by any means, but inebriety does not cause plague.

The children were not liable to contract plague at a Board School. When, however, we arrive at the mother, we find that she worked at a large rag store, and that she was undoubtedly the first victim of the disease. She worked among clean "cuttings" gathered in this country. But though the cuttings were clean, her surroundings were not of the most salubrious kind. For

instance, bales of rags were found on each of the big flats of the rag store, and many of these bales came from the Continent *via* Amsterdam. The mother informed me that she was greatly annoyed by the innumerable fleas she brought home from the rag store. These fleas did not necessarily come from the clean cuttings. Again, another interesting fact vouchsafed by her was, that several days before she left work she noticed two dead rats lying on the bench near where she worked. What became of these rats I was never able to discover. No other dead rats had been seen. The heads of the firm threw cold water on the rat story. Rats, they informed me, were often found dead after having been crushed by bales. That may also be true, but, knowing the affinity there appears to exist between plague and dead or dying rats, one is constrained to keep an open mind on this point. I am quite well aware that the rat and flea theories of infection are discredited. On the other hand, one is confronted with the unanswerable fact that plague bacilli do not lurk about the Leith streets nor about our Board Schools. No one can tell whence the rags came that reached Amsterdam and subsequently Leith. It will not suffice to negative the suggestion of rags as the possible carriers of infection. That infection may lurk in merchandise carried for long distances has been proved by instances quoted by Professor Simpson. He cites several cases where infected clothing, after being transported for long distances, ultimately led to the outcrop of cases of plague. Empty sacks taken from Bombay gave rise to plague infection far up country, and so on.

That the association of rats with plague is close, can scarcely be denied. In the Central Station Hotel in Glasgow one or more members of the staff developed plague, and when the floor upon which they stood was lifted, several rats that had died of plague were discovered. Coolies handling dead rats have been smitten with plague, whilst hundreds of blacks working under the same roof but not interfering with rats escaped the disease; and lastly, one must not forget that rag stores were connected with the Glasgow outbreaks. Had there been a rat infection in Leith, there would have been something to show for it in the direction of rat mortality, and very probably more cases of plague. It may be argued that no dead rats were associated with the first Glasgow outbreak, yet there were thirty-three cases of the disease. Here, however, one must remember that had the first case of plague been timeously diagnosed in the west, there might have been no further spread of the disease. The fact remains that in the first family attacked with plague in Glasgow one of the members was employed in a rag store.

I do not intend to burden my contribution with a recapitulation of the sanitary measures adopted to combat the outbreak. For an important trading centre like Leith, much depended upon the early arrest of the disease. A spread of the disease even in a minor

degree would have seriously dislocated shipping. Several firms had tentatively made arrangements to make Granton their headquarters.

Consequently great efforts were made to satisfy foreign authorities that every safeguard was being adopted to protect outgoing vessels and their crews. Every vessel was fumigated with sulphur prior to its departure, and when the holds were empty. The crews were medically inspected immediately before sailing, and during their stay at Leith guards were placed upon all mooring ropes and hawsers to prevent the passage of rats to and from the vessels. The residents of the infected tenement were at once removed to the reception house, where they were detained for ten days, and medically examined daily.

At the end of five days, that being the time fixed upon by the Paris Convention of 1903, Leith was declared a free port. In the Venice Convention of 1897 the period was ten days.

The measures adopted at Leith freed all outgoing vessels from quarantine restrictions at foreign ports. This in itself was satisfactory. I did not follow the course of splashing quantities of disinfectant about the infected district, but rather aimed at securing cleanliness and airiness of interiors. In this work the lady attached to the department was of great assistance. Heaps of rubbish were removed from back yards, and all the alleyways limewashed with chloride of lime.

Lastly, there remained the destruction of rats. The crusade against them is at the moment of writing this still going on, and many hundreds have been destroyed in various parts of the town; but no plague infection has been found among these rats.

Acting upon the knowledge that the *Bacillus typhi murium* was pathogenic to rats and mice, the organism was culturally grown by Dr. Danysz, and when poured over bread rats and mice eat it, sicken and die. It is claimed that after eating the virus, such being its commercial name, an infected rat will spread the disease to others. On this point I cannot speak with confidence.

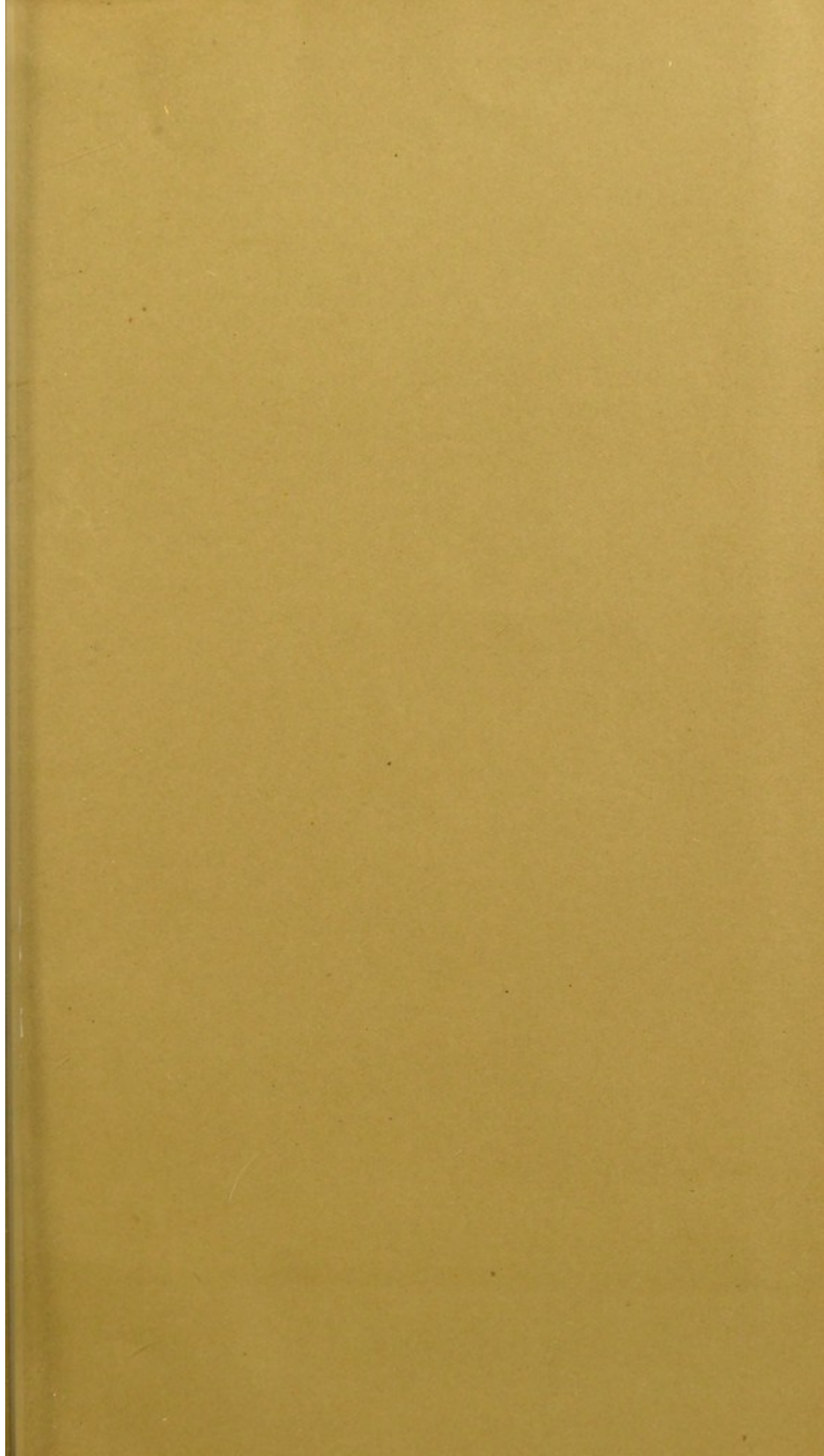
The Odessa authorities cleared the city of rats by using the virus. In Capetown the experiment was also useful. On the other hand, Professor Hunter Stewart and Dr. Chalmers of Glasgow do not speak encouragingly regarding their experiences with the virus. We have now been using the virus in Leith for some weeks, and I intend to continue its use, because several firms whose premises were overrun with rats have no hesitation in telling me that the difference in the numbers of rats since using the virus is perfectly patent. In fact, so impressed are they with the value of the virus, that, Oliver-like, they are asking for more. It may be a slow process, but it is a valuable one if pushed and systematically put into effect. I have myself seen the infected rats lolling about obviously sick and in distress. They appear to be dazed and lethargic. Their coats are roughened, and their bodies bloated.

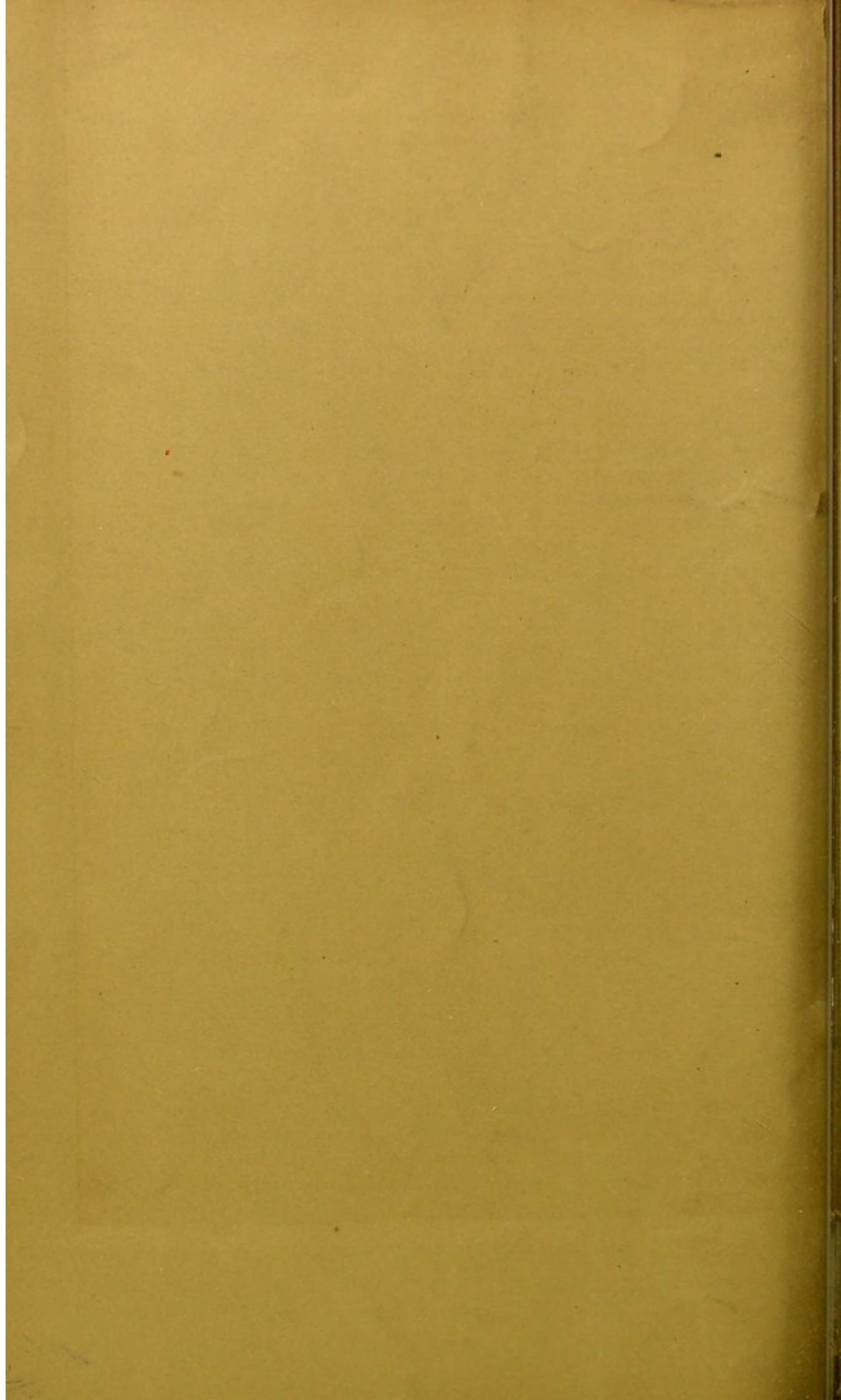
When found dead—and numbers have been so found—their bodies are enormously distended. The only real objection that can be levelled against the virus is that rats dying of the infection have the awkward habit of breathing their last under the floors of dwelling-houses. The resulting stench is at once followed by complaint to the Public Health Department, but we have kept silent as to the cause of death.

Poisons such as phosphorus paste are good in their way, but other animals may reach the phosphorus. Rats are extremely cunning too. They may partake of the phosphorus to-night, but the experiences of the burning sensation created in their throats must be told to other rats, for phosphorus paste is for a considerable period left severely alone.

Most rat-catchers are a delusion. They may produce a few live specimens during the course of a week, but that is all. In Leith two rat-catchers were employed for three weeks, and the number of rats they caught was trifling. They can tell one where rats may be found, but that is all.







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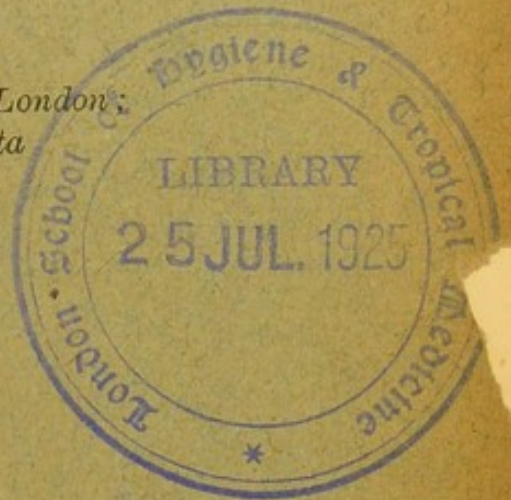
PLAGUE IN INDIA^{21.}

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BY

W. J. SIMPSON, M.D.

*Professor of Hygiene, King's College, London;
Formerly Health Officer, Calcutta*



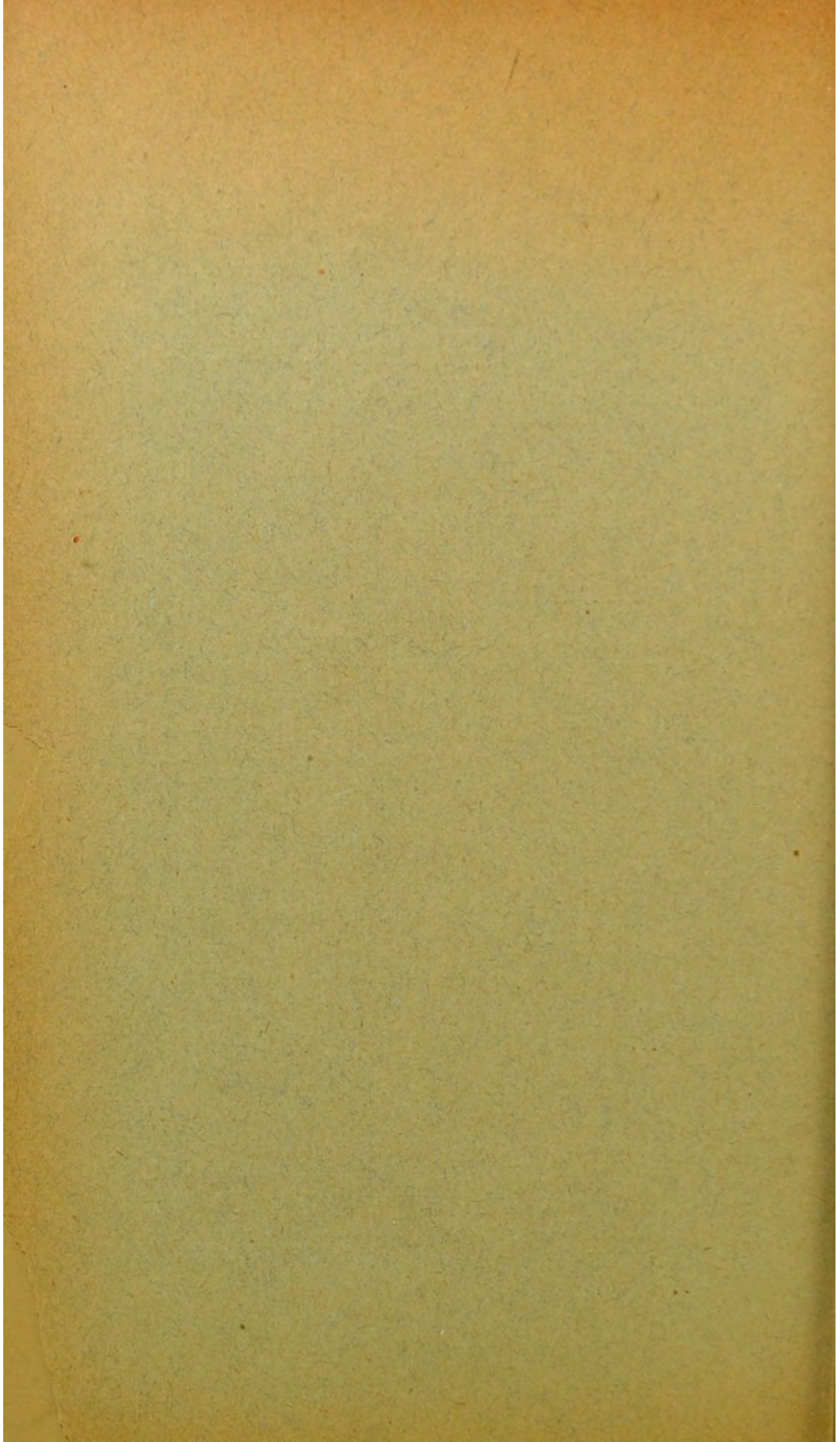
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IN opening the discussion on the plague in India there is one point upon which I am sure we are unanimously agreed, and that is the great admiration we all feel for those Englishmen and Englishwomen—and by English I include Irish and Scotch—who have displayed so much devotion and courage under circumstances of most exceptional difficulty and alarm. Officers, both civil and military, soldiers, ministers, missionaries, nurses and doctors, have distinguished themselves in no common degree in their fight against an invisible and destructive foe. As a profession we may be proud of the achievements of the medical men, both European and Native, official and non-official, who, short handed, have laboriously done all in their power to mitigate the effects of the disease and check its ravages; and equally with the profession I would include that essential auxiliary, the staff of sisters and nurses, whose noble work in the hospitals in nursing the plague-stricken Indians ought never to be forgotten. Such exceptional medical services, whether scientific, preventive or curative, it is to be hoped will be liberally recognised by some mark of distinction, both by the Home and Indian Governments.

In the short time at my disposal it will be necessary for me to limit my remarks on plague to only a very few subjects, and consequently I shall not deal with many of the well-known facts concerning this disease, nor with the clinical aspects of its different varieties,

nor with the rapid advances in our knowledge of its bacillary nature, since the discovery of the microbe by Kitasato; nor even, enticing though it be, with Haffkine's brilliant discovery of a plague prophylactic, which in the observations that have been made shows a reduction in the mortality between the inoculated and the non-inoculated of over 80 per cent. I do not touch on this important subject, because I observe that the distinguished scientist has sent a paper on anti-plague inoculation to this meeting of the Association.

I shall accordingly confine my remarks first of all to some of the phenomena connected with plague that are still obscure, and which require special research for their elucidation; and secondly, to the increasing importance to India and to England of India's possessing a thoroughly trained health service, in which shall be included along with the European, the best native medical element of the country.

With reference, then, to my first subject, it may be taken as an axiom, I believe, which no one doubts, that sanitary measures exert a most powerful influence on plague; that social conditions also play an important part; that the incidence of the disease is more severe on the inhabitants of dark, damp and filthy dwellings, such as are to be seen in their worst form in the large cities of the East; that overcrowding favours its spread, and that sanitation in its widest sense is the best agent to combat the disease. At the same time, I think it must be admitted that our knowledge of the disease is very imperfect, and that there are other powerful factors which, owing to unfamiliarity with the disease, there is a tendency to minimise or ignore, and which must be counted with and studied if the disease under the present conditions of the East and West is to be brought under control. In considering these factors it may be necessary to revise some of our views concerning plague.

Not long since it was a current and favourite doctrine that the plague of London was stamped out

by the fire of London, which gave a healthier city. Such an explanation appealed to the sanitarian, but when tested as to its truth the fact could not be overlooked that plague continued in London for thirteen years after the fire, that it disappeared as quickly from other towns in England as from London, and that the newly built London was little better than the old, for Sir Christopher Wren's plans were not carried out. Again, in the recent outbreak in Bombay, plague was considered a local disease which would not spread. Its manifest slowness in reaching any general proportions was taken as a sign of its incapability of diffusion, the fact being overlooked that this is one of the important characteristics of most plague epidemics. It is easy to be wise after the event, and none can gain credit now by showing that plague has spread over the whole of Western India, even up to the North-eastern Provinces. It is possible, however, that some light may be thrown on this subject by viewing it from its epidemiological aspect, and in this connection it will be useful to compare the liability of India to plague with that of Western Europe.

The information concerning early outbreaks of plague in India is very meagre and furnishes little material for comparison with the outbreaks in Europe, but the little that is to be gathered seems to support the view that plague in India synchronised often if not always to some extent with the great diffusions or pandemics in Europe, and in this respect India, like Europe, was subject to destructive occurrences at long intervals, and shared in those sudden cessations of the disease which were conspicuous in Western Europe in the 17th century. Though the reports are meagre, there is no doubt that plague is not new in India. It is recorded that the Justinian plague of 542 A.D., which is supposed to have arisen in Ethiopia and Egypt, not only spread to the West along the coast of Africa and over Europe, but also to the East over Asia, Persia and the Indies. Plague, which from the earliest times has been associated with trade, mer-

chandise and commerce, or with movements of large bodies of men, followed in this pandemic the general lines of intercourse of those days. Although no special pandemic is noted between 542 and 1334, the epidemics in Mahommed Tughlak's time, and later in 1399, being probably parts of or remnants of the black death, which is believed to have arisen in China, and which is stated to have been very destructive to the inhabitants of India, yet the disease must have been well known to the Hindus, for one of the Purans, written at least 800 years ago, gives instructions to the Hindus as to the precautions they are to take in the event of an outbreak of plague, and one of these instructions is particularly interesting, because it shows that the authors were familiar with one of the methods of spread of the disease and with the precaution that was to be taken against it. It is to the effect that *whenever they observe a mortality among rats they are to leave the locality*. If we were to judge from a perusal of some of the recent literature on plague, the connection between rats and plague is a new discovery, whereas it is only a re-discovery of a fact which was known to the Hindus and as I shall later show, has been observed from the most ancient times. Plague is also noted as prevailing in some parts of India in the 15th and 16th centuries.

Plague prevailed in Bombay City and its environments in the 17th century, from 1689 to 1702, forming a part of that general eruption which is recorded as having prevailed in Western India and possibly even earlier in some parts of India, from 1684 to 1702. It corresponded in time with a wide diffusion of plague in Persia, the eastern branch of an activity in Syria, which had its western branch in a wide diffusion in Europe in the 17th century. Surat at that time was commercially, for India, a more important town than Bombay, and was attacked with plague in 1684, *i.e.*, five years before Bombay. It possessed all the unwholesome conditions which have been observed to favour the prevalence and virulence of plague.

Crowded and unclean, the streets were usually narrow, and in many places covered with excrement of man and beast. Fryer, who visited Surat some time before the outbreak, wonders that a city whose people make the streets a dunghill should never have been visited by the plague. The disease, when it was imported in 1684, continued for six years without interruption, varying in intensity at different seasons of the year. Subsiding during the rainy season, viz., from June to September, the epidemic broke out with fresh fierceness in October, and again abating the greater part of the cold and hot seasons, raged with renewed fury towards the end of May. The death-rate at times, on a very modest calculation, amounted to 300 a day. The same remarkable immunity of Europeans was noticed in the epidemic of Surat as that exhibited in the recent epidemic in Bombay. It is mentioned that up to 1689 no Englishman had been attacked in Surat, which is in striking contrast to what happened in Bombay in 1690, for in regard to this city it is recorded that of 800 Europeans only fifty were left—six civilians, six commissioned officers, and not quite forty English soldiers. Bombay, that had been one of the pleasantest places in India, was brought to be one of the most dismal deserts. There is no record of the mortality among the natives in Bombay, a fact which indicates that mortality in the interior of the country, unless on an enormous scale, would not be likely to attract attention.

After the epidemic in the 17th century the plague seems to have disappeared from India as completely and as rapidly as it did from Western Europe, for it is not until 110 years later, at the beginning of the 19th century, that a small part of Western India, viz., Kutch, Kattiwar, Gujerat, and Sindh, were again affected with the disease, which continued from 1812 to 1821. It is deserving of notice that this epidemic occurred at a time when plague became widely diffused in the Levant, spreading to the Lower

Danube, Asia Minor, Armenia, and Northern Africa, and lasting nearly twenty years.

Nothing more is heard of the disease on the Western side of India until 1836, when the Pali plague broke out in Marwar in Rajputana, and lasted until 1838. The epidemic, which was limited in its nature, also corresponded in time with a fresh and comparatively limited activity in the Levant, which affected the Turkish dominions in Europe and Asia as well as Egypt, and it is to be observed that the disappearance of plague in Rajputana coincided with its decline and ultimate disappearance in the Levant. Plague was, however, discovered in 1823 as prevailing in the extreme North-west of India in the province of Kumaon and Gharwal, which adjoin one another, and are on the Southern slopes of the Himalayas. There is no information as to how long this centre of plague had existed previous to its recognition. It is possible that as the plague of 1896 in Bombay found its way in 1897 as far as Jullundur in the North-west, that the plague in Kumaon in 1823 was only a part of that which had prevailed in Western India in 1821. Whatever may be the date of its origin, there can be little doubt that Kumaon is now an endemic centre, plague having occurred in limited outbreaks even as recently as 1893. The last outbreak, which was in July and September of 1893, occurred in a valley some 6,000 feet high. Fortunately, this centre is a comparatively inactive one as regards its powers of diffusion, which is in favour, as I shall afterwards show, of its being a branch of the parent stock in the Levant. An epidemic in Hansi, in the province of Delhi, in 1828-29, and in Rohilcund, around Bareilly, in 1836-38, probably owed their origin to Kumaon. In connection with the possible antiquity of Kumaon as a plague centre, there is the fact that plague was epidemic in Delhi in the time of Jehangir. On the other hand, Delhi at that time was a large commercial emporium, having much dealings with the West.

The intervals of freedom from plague, so far as is known, are as great in India as in Western Europe, and would indicate that the disease is as much an exotic to India as to Western Europe. The tendency to linger a number of years in one locality or district can scarcely be taken as evidence of endemicity, but rather as manifestations of the same invasion in which the germs have not succumbed to the influence of the new environments. The same is seen with cholera, whose home is fairly well defined. Bombay, with its freedom from plague for one hundred and eighty-four years, shows a longer interval than Moscow, in 1771, which had not been attacked for one hundred and fifty years; or Marseilles, in 1720, after a lapse of seventy years; or London, in 1499, after an interval of one hundred and fifty years. These long intervals are worthy of attention because they show a vulnerability of towns, which from their long freedom might be considered invulnerable.

Moreover, the cessation of plague in Western India at the beginning of the 18th century was apparently as complete, as rapid and as remarkable, as the cessation of plague in Western and Central Europe at the end of the 17th century. At this period plague disappeared from the greater part of Western Europe in the course of ten years, and completely in thirty. A still more remarkable disappearance is that which took place towards the middle of the 19th century. Then, in the course of five years, from 1839 to 1844, plague disappeared from its old haunts in South-eastern Europe, the Levantine Countries and Egypt. Hitherto it has been impossible to satisfactorily trace these sudden disappearances to special measures devised for that object, and it must be confessed that it is not possible to be satisfied with the accuracy of the current explanations to which these disappearances have from time to time been attributed. In all the explanations it seems to be the case of the fire of London over again, only on a more extended scale. A favourite explanation, and

one that has been repeated just lately by an eminent authority, is advancing civilisation. It is a pleasant and comfortable hypothesis, but it may be asked what advancing civilisation got rid of plague in India in the 16th and 17th centuries, and of plague in the Levant and Egypt in the middle of the 19th century in the course of five years?

The Levant and countries adjoining have been the centres of plagues for at least three thousand years, the first notice of the disease being in Syria, when the Philistines, after defeating the Israelites at the battle of Ebenezer, were affected with plague, which attacked city after city, causing a deadly destruction. As a propitiatory offering, the Philistines made *images of their emerods and images of their mice that marred the land*. It is evident from this reference that the mice were thus early considered to play an important part in plague epidemics. The plague of the Levant has lost not only its powers of diffusion but the power of retaining its hold on countries in which it had appeared for centuries almost as regularly as the seasons. Nor does there appear to be any indication at present to regain these powers, for in the several recrudescences which have taken place in Mesopotamia, Asia Minor, and in Northern Africa, it has been pointed out by Tholozan that they are restricted outbreaks partaking more or less of a local nature, showing no special aptitude for diffusion, and though retaining their fatality, localising themselves independently of quarantine. The plague at Resht and at Astrakan arrested itself before quarantine was introduced. The same cessation of plague of a localised character appears to have occurred in the western part of India, for after 1840 no more is heard of plague until 1896, and then not in connection with a recrudescence or fresh activity of a widely diffusive nature in the Levant, but with a fresh activity of a widely diffusive nature in China. The plague of 1896 in India had not the character of recent recrudescences in Mesopotamia, Persia, and Kumaon, which were

largely local in their nature, but it possessed, and still possesses, powers of diffusion, which characterised the outbreak in China.

Apart from other considerations as to means adopted to prevent the spread of plague, it is an important question epidemiologically, whether this pandemic of the far East has enough diffusive power to pass on into the Levantine countries and thence into Europe. If we were to judge by the events at Jeddah, where the plague, though imported, seemed to acquire no foothold, the answer might be no; but the data at present are insufficient for so decided an opinion. One of the features of plague is that it is a disease which is slow in its advancement. All that can be said is that this new recrudescence in the far East has apparently nothing to do with the old centres in the Levant, and it is necessary to be particularly careful not to be too much influenced by the experiences which the Levantine plague has presented to us for the past hundred years, otherwise there is the danger of repeating the mistake that was made in Bombay in 1894, of considering it a local disease unlikely to spread. The plague of the Levant during the past century was totally unlike the present plague that has arisen in China. The Levantine plague was, and is, distinguished as an inactive, contracting plague, belonging to a species that has had its day and is dying; the Chinese as an active expansive plague, full of potentialities, and only requiring the opportunities to manifest itself. The rapid spread of the disease in China and now in Western India is sufficient evidence of vitality and diffusive power. When plague broke out in Bombay in 1896 it spread from that city in every direction, infecting nearly the whole of the Bombay Presidency, Kutch and a part of Sindh. As shown by Surgeon-Captain Grayfoot, a large number of the localities were infected by imported cases, and that in many a considerable time elapsed between the first recognised case and the first indigenous case, and that again some time intervened between the first

indigenous case and the subsequent epidemic. Thus at Sholapore the first recognised imported case was on December 17, 1896; the first recognised indigenous case on September 28, 1897, *i.e.*, more than eight months later; while the disease did not become epidemic until November, 1897. In districts adjacent to one another it was frequently noticed that the migration of rats, or the "rat's progress" as it has been called, seemed to play an important part in the spread of the disease.

Plague spread in a north-easterly direction as far as Jullundur in the North-west, where it was never permitted to assume an epidemic form. Possibly the disease was more easy to control and stamp out in the North-west, because villages and not large towns were infected and obviously the conditions are not alike; but the success, I think, may in no small degree be attributed to the enlightened policy of the Lieut.-Governor and his confidence in his medical advisers from the commencement. Immediately plague broke out in Bombay Sir Anthony Macdonnell sent Mr. Hankin from the Agra laboratory to study the plague bacteriologically, and allowed him to remain there until the North-west Provinces needed his services. Prompt attention to first cases, segregation, evacuation of the village, camping out, isolation of the village and disinfection, were the principal measures adopted, and Surgeon-Lieut.-Col. Thomson and his assistants are to be congratulated on the successful manner in which they have combated plague in the North-west.

The time and manner in which Bombay became infected is of great epidemiological and practical interest. Unfortunately both time and manner are involved in obscurity, and are likely to remain so. It seems to be the fate of most epidemics of plague in large towns for their origin to be obscure. Apart from the fact that the presence of plague is always very reluctantly acknowledged, because of the important interests that are likely to suffer, and that the

disease is extremely slow in manifesting itself to any alarming extent, the obscurity may be due to the fact that some of the lower animals are affected with the disease in an unrecognised form, that the pneumonic variety in man, which was shown by Surgeon-Captain Childe to be produced by the bacilli attacking the lungs, may be mistaken for some other form of lung disease, and that there are mild forms of plague which are not easily recognised. The identity of the disease in rats with the plague in man was demonstrated by Dr. Surveyor, the bacilli from both responding to the same tests. Possibly the Chinese view regarding the gradation of animals infected, and the relation of the disease to the soil, though somewhat fantastically expressed, has much truth in it. In treating of the plague in London in 1603, Lodge mentions rats and moles and other creatures accustomed to living underground, forsaking their holes and habitations, and attributes it to corruption in the soil. Pigs have been shown by Wilm to be affected with the disease. Boccaccio mentions the death of two hogs from plague which he witnessed in Florence in 1348. Snakes are recorded as dying from the disease, and Nuttall has produced the disease in snakes experimentally. In many epidemics epizootics are also observed either to precede or coincide with outbreaks. Surgeon-Lieut.-Colonel Weir, the Health Officer of Bombay, observed this in Bombay, and gives statistics showing that in August preceding the outbreak of epidemic plague in September there was a heavy mortality amongst cattle, sheep and goats. Monkeys were affected in Hurdwar, and it is a curious fact mentioned in Surgeon-Major Lyon's report that the grey monkey was much more susceptible to the plague than the brown monkey. With these facts before us, it is evident that plague is not a simple disease to be easily dealt with administratively.

It is certain that the recognition of plague in Bombay in September, when it was described as a mild form of plague, was not its first manifestation, and the

date has gradually been pushed back to August, July, June and May, and even to February, when, as described in Mr. Birdwood's able lecture at the Society of Arts, Dr. Kay, medical officer to the G.I.P. Railway Company, treated several plague cases at the Bycalla Infirmary of the Railway Company, which though he did not recognise them as plague cases at the time, his after experience convinced him had been really cases of plague. It is possible that the date may have to be pushed back even farther than February, 1896, for as Editor of the *Indian Medical Gazette*, I received in 1896 a letter from a medical officer on the Malabar Coast, describing some cases of peculiar fever with glandular enlargements under his care, I think in 1895, and over which he was much puzzled; unfortunately I mislaid the letter and was unable to recollect the medical officer's address. Perhaps the mention of it at this meeting may bring this important matter to the medical officer's notice.

That a disease, such as plague, may exist in a mild form for a long time before it manifests itself, either in its more virulent type, or in a local outbreak of considerable dimensions, may be gathered from the occurrences in Calcutta. The facts briefly stated are, that the Shropshire regiment which distinguished itself in Hong Kong, in cleansing plague-infected houses, lost three of its number in that colony from the disease, while double that number were attacked. From that time the regiment at intervals suffered in small groups from fever accompanied by glandular enlargements. This illness they brought with them to Calcutta, in January, 1895, and then other drafts of soldiers, who had never been to Hong Kong, but who were brought in intimate association with their affected comrades, were attacked with a similar malady. At first the disease was diagnosed as syphilis, then as malarial fever with bubo, and ultimately the cause was registered as unknown. Some medical officers considered it to be a new disease; one of the medical officers was attacked in

June of 1896, and the glands of the groin, axilla and neck were affected. In October, 1896, besides an imported case of illness from Bombay, with fever and glandular enlargements, a number of cases occurred in Calcutta, but with symptoms of a more acute form, and of less duration than the cases in the Shropshire regiment, which was still continuing to get fresh cases. There were fever, white-coated tongue with red tip and edges, congested eyes, dull intellect and glandular enlargements, mostly in the groin; children and young adults were chiefly affected. An adult who was affected and died, had all the typical symptoms of plague. From experience gained later in Bombay and Poona, I have not the slightest doubt that two other suspected cases which proved fatal were cases of plague, and that the other cases of fever with glandular enlargement were benign plague, more severe in its character than some seen by me in Bombay and Poona. A peculiarity of these mild cases was that in some, a bacillus similar to the bacillus of plague was found in the blood. It could not be cultivated, however, unless, as it seemed to me, large quantities of blood or serum was drawn. In one portion of Calcutta, somewhat later, there was a glandular and very fatal illness among rats, whose organs were filled with diplobacilli, similar to the plague bacilli. Sick rats left their holes and slowly hobbled about or rested, apparently in a dazed condition. As many as 100 affected rats were counted in one small grain depôt in one day. The houses were treated as plague-infected, a campaign was waged against the rats, and evidently with success, for the epidemic among the rats ceased. It is necessary to state here that my views regarding the nature of this glandular sickness among the inhabitants was not held by a higher authority, and that isolation of such cases was considered unnecessary. On the other hand my further experience convinces me that the medical men who agreed with my views were right in their diagnosis, while some of the microscopical specimens

sent to Kitasato elicited the opinion they were probably plague bacilli. Unfortunately the cultures I took to Haffkine were old and gave negative results. In connection with the occurrence of such cases in Calcutta, and their nature, the Report, dated July 16, 1897, of Dr. M. J. Rosenau, the Quarantine Medical Officer to the supervising Surgeon-General of the United States Marine Hospital Service, which I came across the other day, is interesting and confirmatory. It is as follows:—

“ NATIONAL QUARANTINE STATION,
“ ANGEL ISLAND, CAL.,
“ July 16, 1897.

“ SIR,—I have the honour to report the British ship ‘ Annie Maud,’ one hundred and forty-three days from Calcutta, was placed in quarantine to-day for disinfection. A short while after leaving Calcutta one of the crew was taken ill with swellings in the axilla, groin and elbow, and died. Two more of the crew suffered with buboes, from which they recovered.

“ Very respectfully,

“ M. J. ROSENAU,

“ *Passed Assistant Surgeon, U.S., M.H.S.*”

One other point is deserving of notice, viz., that early in 1897 there was an epizootic outbreak among cattle in the same locality in which the rats had died some months before, and though it was called rinderpest at the time, the symptoms differed somewhat from the ordinary cases under that name, and *post-mortem* examination showed a very congested and enlarged condition of the mesenteric glands.

Plague has now manifested itself in larger proportions in Calcutta, and within three months has caused 128 deaths. It is to be noted that the cases are no longer mild, and that they are well distributed over different parts of the town. There was the same difference of opinion in regard to the nature of these cases of fever with glandular enlargements as in 1896, until Haffkine decided the question by reporting the nature of the bacillus.

The early cases in March and April of 1898, in Calcutta, were set down as cases of bubonic fever, which recent statements would lead one to believe is quite common in Bengal, and is only malarial fever accompanied by buboes. All that can be said about such cases, and I have made careful inquiries, is that some of the most experienced practitioners in Bengal have not come across these cases until a short time ago. The same erroneous mode of viewing mild cases of plague found favour in the Pali epidemic of 1836, but it was conclusively shown by Dr. Forbes that no such fever attacking the lymphatic glands was known in the Pali district or in that part of India, except in connection with plague. Dr. Forbes divides the Pali plague seen by him into four forms: (1) an ordinary bubonic; (2) a more violent and malignant; (3) a most fatal pneumonic; and (4) an extremely mild form in which the glandular swellings made their appearance with little constitutional disturbance and were attended only by languor, debility, and a general feeling of indisposition. They went on slowly to suppurate, and health was gradually restored. Dr. Forbes' description of this mild form is similar to that given by Foderé as applying to the benign plague observed in the Levant and in Marseilles in 1720, and concerning which Foderé declares *that it is no less plague than the other forms, and equally demands the attention of the physician and of the magistrate.* Similar cases were described by Dr. Duthieul as occurring in Mesopotamia in 1856, and these were observed in Bengehazi, in North Africa, in Astrakhan, and in the early period of the Vetlianka outbreak in Russia. It is remarkable also, as pointed out by Dantlie, that for some years preceding the outbreak in China there had been in Hong Kong, South China and Singapore, a prevalence of a previously unknown affection distinguished by fever and glandular enlargements. One of these cases imported from Singapore was seen by me in 1897 in Calcutta, at the request of a medical man there, and it corresponded with the

chronic affection from which the soldiers of the Shropshire regiment was suffering.

The fatality of plague naturally attracts the most attention, and unless the malady is fatal it has hitherto been considered to be any disease but plague. This view, however, requires to be revised, for when opportunities arise for special observation mild cases and mild epidemics are found to prevail alone, or co-exist with those of a severe type. The outbreak among the Souttars of Kosumba Village, inquired into and reported on by Surgeon-Captain T. E. Dyson, Deputy Sanitary Commissioner of the Gujerat district, illustrates one of these points. Here, according to Dr. Dyson, "the disease was of a mild type, characterised by slight fever of two or three days' duration, and the formation of buboes chiefly in the groin. Fully three-fourths of the thirty-one cases which occurred were of this type, and during one visit to the village I found two boys, about 12 years of age, with buboes in the groin, whose fever had been so slight as to escape observation, and they had not been recognised as plague." Surgeon-Lieut.-Col. Weir, Surgeon-Lieut.-Col. Dimmock and others, much engaged in plague work, have observed and recorded such cases.

It appears to me, then, that it is in the milder types rather than in the severe forms, in the pneumonic forms and in the disease among animals, that the obscure beginnings of some epidemics of plague, in a previously healthy locality, should be searched for, and that the sanitary officer of the future, if he is to deal with plague in its early stages, must be well versed in the different types of the disease in man and in its manifestation in animals.

In other respects our knowledge of plague is defective; for instance, the mode of entrance of the microbe into the human body, the medium or media by which it gains that entrance, and the life history of the microbe outside the human body are still unknown, and consequently the plague is being fought under the most disadvantageous conditions. There are

theories and explanations, but there is nothing on a sound basis. With the exception that the microbe of plague has been discovered, the existing conditions in regard to plague are much the same as those which prevailed fifty years ago in regard to cholera, before Snow's discovery that contaminated water carried the poison. Previous to then the measures introduced to combat cholera were of a general hygienic nature, the special being submerged in the general and not infrequently overlooked, while much energy and money were expended on the rectification of hygienic defects which had little or nothing to do with the spread of the disease. This must always be the case until our knowledge concerning an epidemic disease is complete.

Most of our knowledge concerning plague is in a fluid condition, principally because it is a new disease to the present generation of medical men, and because the opportunities afforded for its study in India have not been taken sufficient advantage of. In fact, they are great opportunities lost. Good work has undoubtedly been achieved by the different Foreign Commissions sent out by the several European Governments, and by the scientific Committee appointed by the Government of Bombay in corroborating and adding to the researches of Kitasato on the bacillus, but the essentially English method introduced by Simon and his contemporaries, and which is continued with such excellent results by the Local Government Board, has not been applied—I refer to the regular and systematic investigation of plague by special and thoroughly trained medical officers, case by case and outbreak by outbreak, including all the circumstances connected with each, and combining with this research laboratory work. This ought to be done, no matter what is the cost, for at the most it can only be insignificant to the losses which India is being now subjected to. It was reckoned that Bombay at the time of the height of the plague lost £100,000 a day. Over 100,000

persons have died of the plague in Western India. The other day I heard Lord Reay declare that plague is the most important problem that the Government of India has to deal with. There can be no doubt that this is so, politically as well as socially, and I would plead for the inhabitants of India, and for the sake of those who have commercial and social interests with her, and for the sake of humanity, that every effort which science and money can afford should be made to learn more about this disease.

This is impossible under the present arrangements, owing to India possessing no trained sanitary service. This is a subject I dwelt on very fully in 1894 at the Indian Medical Congress, and there was a resolution of the Government of India that such a service was to come into existence in the year 1900. The plague has probably upset the arrangements intended to have been made before such a service can be established, the first arrangement being the education in sanitary science in medical schools of the members of the proposed service. Plague has emphasised the absolute necessity of this service and the utter helplessness of India to combat disease without such a trained service. I divide the medical part of a sanitary service into three branches—(1) the administrative, (2) the investigative, and (3) the scientific. The three should be in close connection with one another, and in large towns should form parts of one large department. Broadly in England, the administrative is represented by the local health officers and their subordinates, the investigative by the medical inspectors of the Local Government Board, and the scientific by the laboratory researches made into the causes of disease in connection with special investigations of either the medical inspector or local health officer.

In the absence of a proper sanitary service in India, laymen had to direct the operations against plague in Western India, and in a number of instances soldiers had to be employed for house-to-house inspection.

Apart from the fact that it is impossible to turn

men suddenly into well-trained sanitary inspectors, there was always the risk, among a highly imaginative people, unaccustomed to see the military in their houses, of considerable alarm being created, which would be intensified by the wildest rumours; while it was certain to give a handle to the many political agitators, who are only too ready to seize every opportunity for brewing discontent and mischief. However suitable the system might be for a military station, it could not be adopted for Indian towns generally. The policy which has kept the military apart from the people except in cases of riot and other exceptional instances appears to be one on a very sound basis. Plague no doubt is an exceptional event, but it is too much connected with the domestic habits of the people to be dealt with except by agents to whom they are accustomed. To the members of the British Medical Association, as well as to those accustomed to the methods adopted in England with regard to epidemics, the system of placing the control and direction of an infectious disease into the hands of laymen must seem extraordinary. The following extract, taken from one of the despatches published in one of the blue books in 1897, will serve to illustrate the system. It is as follows:—"In view of the rapidity with which plague was spreading in the Satara district, a committee under the Presidency of the Honourable Mr. Spence, and comprising the following officers, Mr. Lely, I.C.S., Mr. R. A. Lamb, I.C.S., Mr. A. C. Logan, I.C.S., and Lieut.-Col. J. W. Wray, all of whom have had wide experience of plague measures, was appointed to devise measures for the prevention of the spread of the disease." I am sure the exceptionally able and distinguished administrators on this Committee, and who belong to a Government which is splendidly organised in other respects, would be the first to acknowledge that an organisation composed of laymen is not fit to deal with epidemic diseases. The system can only be excused under the exceptional circumstances of there being in the country no pro-

perly trained sanitary service whose duty would be to control epidemics. A native and European sanitary service is needed to protect the civil population against the invasion and ravages of disease, just as a European and native army is required to protect them from the invasion of foreign armies.

Later on in the epidemic, by the despatch of Army medical officers and Indian medical officers from other parts of India, and by the sending out of a large contingent of medical men from England by the India Office, a nucleus of an administrative department was formed. But with reference to the Army medical officers and the Indian medical officers, it was only robbing Peter to pay Paul, for many districts requiring European medical officers were denuded of them. As a matter of fact, without plague duties the medical officers of the Indian Medical Service have for many years been overworked and are not sufficient in number for the ordinary duties which have been assigned them and have a well founded grievance in their inability to obtain the leave and furlough due to them. If we now turn to the investigative branch, consisting of a body of highly trained men whose sole occupation is to search out the causes of an epidemic and inquire personally into the manner in which it spreads among the inhabitants, it is found that no such branch exists in India. From the foregoing it will be seen that two of the most important branches of a sanitary service in India have still to be formed.

As regards the scientific branch, the Government of India and the Government of the North-West Provinces have been fortunate in possessing for some years past the services of Surgeon-Lieut.-Colonel D. D. Cunningham and Mr. Hankin. Two laboratories, however, in a vast country like India, do not meet its requirements. Moreover for the past eighteen months Professor Cunningham's laboratory has been closed, owing to his retirement and there being evidently no one to take his place. When the plague broke out in Bombay the Government of India very wisely

requisitioned the services of M. Haffkine, who was on a visit to the country pushing forward his anti-cholera inoculations. And in a short time M. Haffkine announced his brilliant discovery of a new method of combating plague. This discovery was not, I would point out, made suddenly after the Government of India requested him to go to Bombay and provided him with a laboratory, but it was the result of many years' work in the laboratory, beginning at least ten years previously from the time M. Haffkine directed his attention to anti-cholera inoculations. I mention this because there is a disposition in some quarters to consider laboratories expensive luxuries, unless some discovery of the first magnitude is speedily made.

The Government of India has always been imbued with the great importance of establishing laboratories in India, but the state of finances has invariably blocked the way. This difficulty, however, disappeared in a most charming and unexpected manner in 1897, when a number of the Princes in India expressed their desire to commemorate the sixtieth year of Her Gracious Majesty's reign by establishing a Health Institute for India, which should have M. Haffkine as its first director.

The spontaneity of the offer and the generosity with which it was made was enhanced by the peculiar appropriateness of this royal memorial to our beloved Empress Queen, whose reign has been so distinguished for the advances made in scientific and preventive medicine. The Princes were anxious that the site should be chosen and the foundation of the Health Institute laid on the day of the Jubilee. Owing to delays over which possibly the Government of India had not full control, in consequence of its plague and famine work, the auspicious day was allowed to pass and no foundation stone was laid. Everyone acquainted with India will know the importance of an auspicious day. It is the symbol of success and good fortune.

Exciting events follow quickly on each other in

India and crowd out the preceding. War, in this case, with its distractions and expenses, burst out in the North-West Frontier, and the golden moment was lost for the establishment of a magnificent Health Institute, which, while serving as a noble monument of the loyalty and liberality of the Princes, would at the same time be for India a landmark in the Victorian era. Let us hope, however, that the check, however regrettable, is only of a temporary nature, though it requires a sanguine mind to overlook the fact that delays mean new interests arising, a certain amount of chagrin, and the imperilling of a noble project.

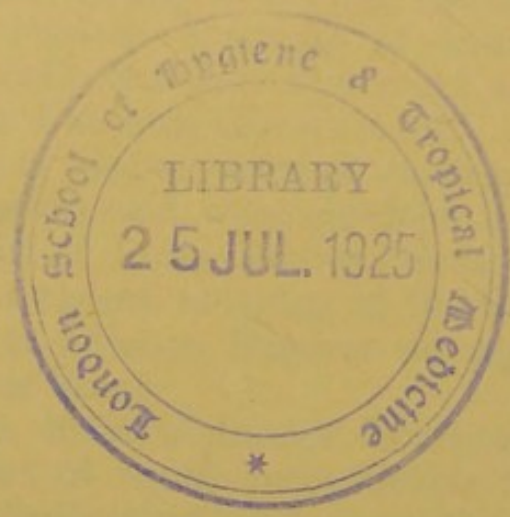
A similar fate, owing to similar causes, appears to threaten the Pasteur Institute of India, for which R.77,000 was collected over two years ago, and a site offered by the Punjaub Government. A letter from the Committee of Management of the proposed Pasteur Institute was addressed, over eighteen months ago, to the Government of India, asking for their sanction to this site. At a recent meeting of the Committee the members had to adjourn because no reply had been received to their letter.

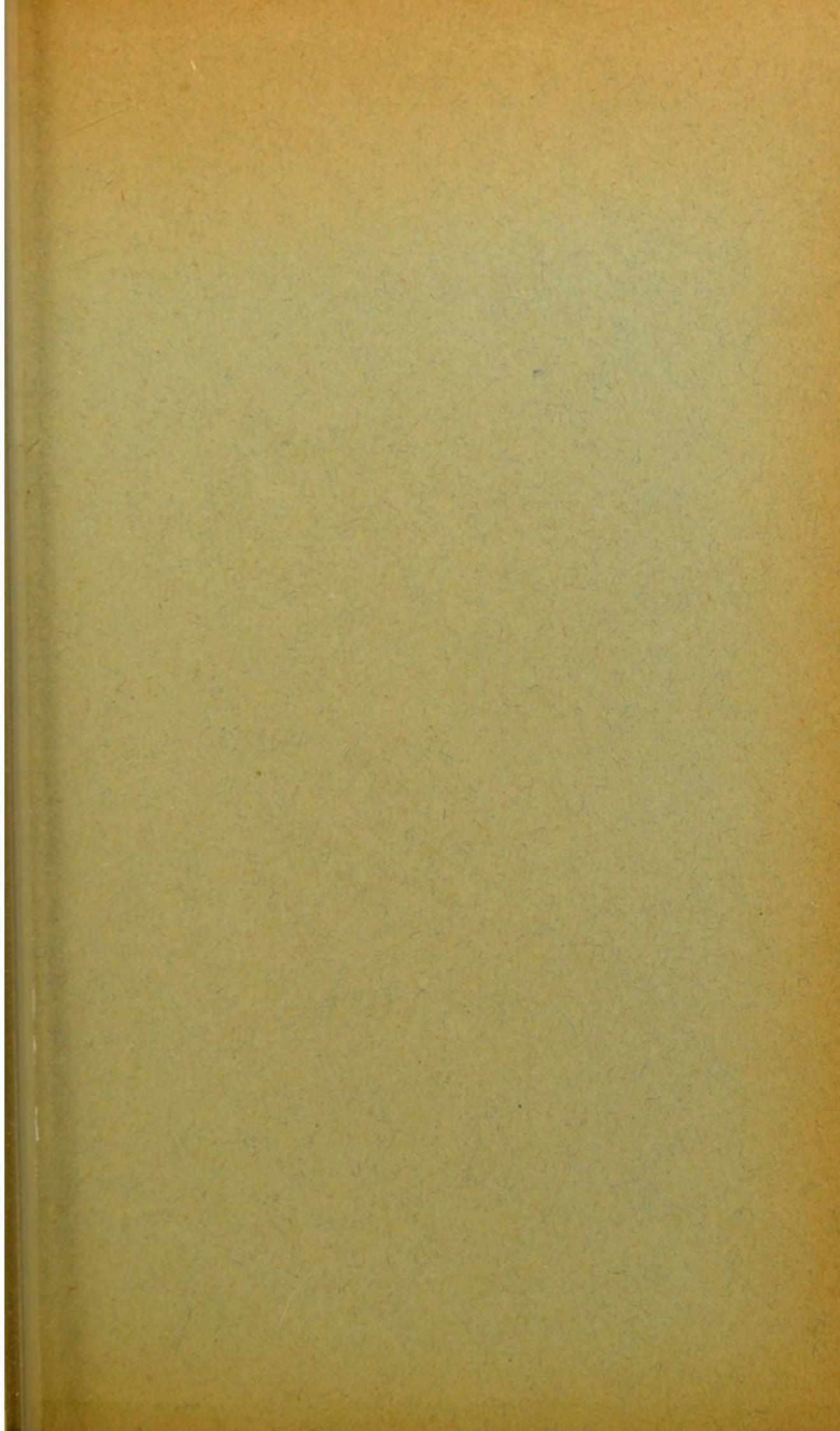
I have given these instances, not because I think the Government of India unfavourable to these proposals, but as illustrating the fact which is too familiar with those interested in sanitary progress in India, that under present arrangements even the most important sanitary matters cannot have the attention paid to them which is necessary, and that the only remedy is a properly constituted sanitary service, similar to that which I drafted in my address in 1894, and which was approved of then by the Government of India.

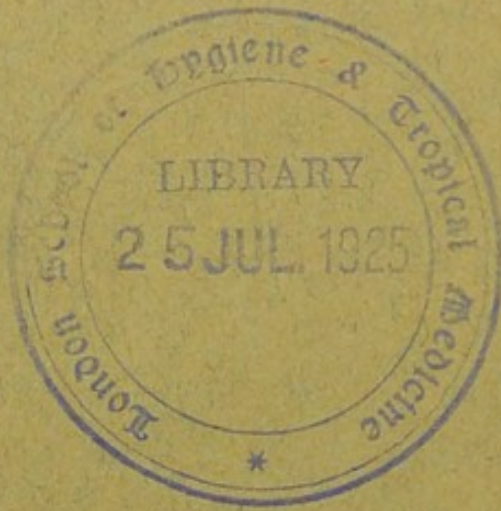
As regards plague in India, it appears to me that the disease has come to stay, at least for a considerable time, and it is consequently important on this ground alone, quite apart from other reasons, that a trained sanitary service should be established, and that while every known effective measure is taken to

check the ravages of the plague, it is also necessary to systematically investigate and study the disease from every point of view, which cannot be done without laboratories and a specially trained service.

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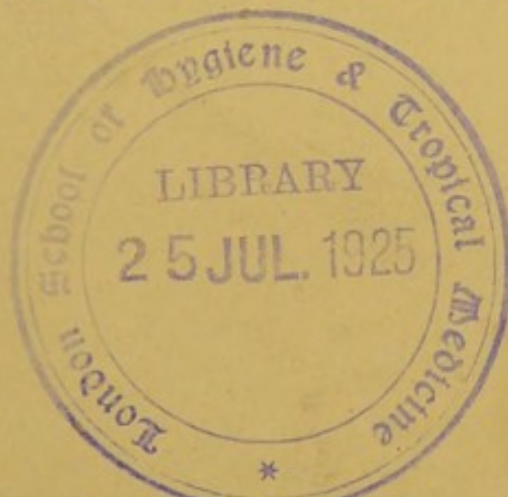
An Address
ON
RECRUDESCENCE OF PLAGUE
IN THE EAST
AND ITS RELATIONS TO EUROPE

*Delivered on August 31st, 1899, at the Eighteenth Congress of the
Sanitary Institute held at Southampton*

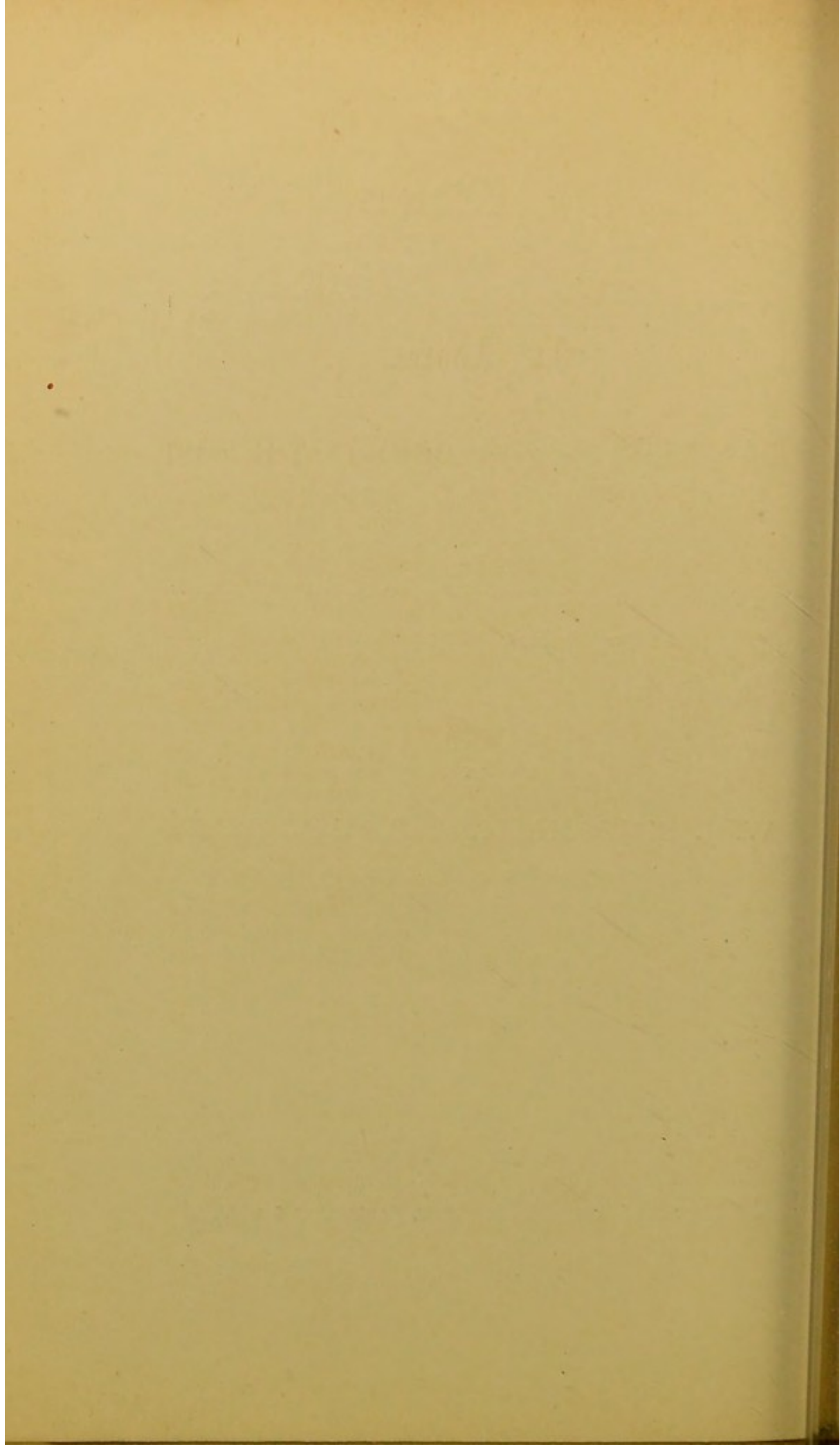
BY

W. J. SIMPSON, M.D., F.R.C.P., D.P.H.

PROFESSOR OF HYGIENE AT KING'S COLLEGE, LONDON.



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An Address

ON

RECRUDESCENCE OF PLAGUE IN THE EAST AND ITS RELATIONS TO EUROPE.

GENTLEMEN,—With plague in Egypt, on the shores of the Persian Gulf, and now in Portugal, a discussion on the possibility of its further extension will not be out of place at a Congress of the Sanitary Institute. The commonly received view that advancing civilisation caused the disappearance of plague in Europe and will accordingly prevent a recurrence of plague epidemics is not supported by historical facts. These show that plague at the end of the seventeenth century disappeared from the greater part of Western Europe in the course of 10 years and completely in 30 years, whilst in the middle of the nineteenth century it even more suddenly disappeared from its old haunts in South-Eastern Europe, the Levantine countries, and Egypt, taking only five years, from 1839 to 1844. No special advance of civilisation characterised these epochs so exceptional in regard to the retrocession of plague. The absence of plague even for a long period is no absolute proof of the immunity of the locality. The city of Bombay was free from plague for nearly two centuries and yet it would be impossible to state that the city taken as a whole is less protected now by sanitation than it was during those two centuries or that the people and its Government are in a less civilised state.

HISTORY OF THE PROGRESS OF THE PRESENT PLAGUE.

Five years ago when plague broke out in Hong-Kong Japan was the only country which owing to its proximity to the centre of the epidemic was interested in the outbreak, and it showed that interest in an active manner by sending a

scientific commission to Hong-Kong to study the nature of the disease. The result of the work of the mission was the important discovery by Kitasato of the bacillus or causal agent of plague, which places us in a much more advantageous position of defence against this disease than that of our predecessors. From Hong-Kong the disease spread through Southern China, little note of its extension being made. Two years later it appeared in Bombay and then the expansive character of the epidemic began to impress itself on the civilised world. In two years it had travelled 3000 miles westward. In India in the course of six months the epidemic assumed most threatening proportions, the general mortality rising in Bombay city to over 1600 a week and important centres in the Presidency becoming infected. Panic, unreasoning resistance to regulations, and flight from the city followed. The infection became still more widely diffused and gradually spread into other Presidencies. The disease once having gained a footing in India continues not merely to spread but also to reappear annually in the infected centres, declining generally during the intense heat and rains and recrudescing in the cooler seasons. The rise and fall is not always regulated by the seasons. For example, a few weeks ago Poona was in the throes of her third epidemic, over 150 of her inhabitants dying per day, which in a town of such small dimensions is an enormous mortality, as may be gathered from the statement that if a similar mortality prevailed in London the metropolis would lose over 10,000 persons a day. The mortality in Poona is all the more serious, as I can state from a personal inspection of the town and of the interior of the houses there that, if inefficient drainage be excepted which allows of water-logging of the soil, it is in no worse a condition as regards sanitation and overcrowding than hundreds of towns of a similar size in Europe and is certainly in a much better sanitary condition than many.

Since its advent the plague has caused in India over a quarter of a million deaths. The annual reappearance which is a distinguishing feature of the plague in India is also a conspicuous quality of the plague in Hong-Kong, and only recently over 100 deaths a week were recorded in the colony.

The European Governments being alarmed at the outbreak in Bombay the Venice Conference was called to formulate rules and regulations for commerce and pilgrim traffic having for their object the prevention of the importation of

plague more particularly into Egypt and Europe as well as into other countries east of the Suez Canal. The rules and regulations have now been in force some two years and during that time, notwithstanding a most rigid adherence on the part of all concerned to the recommendations of the Convention, plague has reached the Persian Gulf, Penang, the Mauritius, the French island of Réunion, Madagascar, Jedda, Egypt, and, if rumour is correct, the Gold Coast of the French possessions in West Africa, and now Portugal, and this extension has happened though the rules were formulated according to the most advanced knowledge on the subject and by the most eminent representatives of the Powers.

The reappearance of plague in Egypt after an absence of 50 years with its extension to Portugal is a matter of profound interest, because it indicates that this plague from China partakes rather of the nature of a pandemic than an epidemic and possesses that which other plague epidemics for nearly the past 200 years have lacked—viz., the quality of diffusiveness which defies the precautions hitherto employed against its progress. This is a feature which contrasts strongly with the spontaneous self-limitation of most of the plague epidemics of the eighteenth and nineteenth centuries.

THE COMMERCIAL CONDITIONS IN THE WEST ARE FAVOURABLE TO DIFFUSION.

The intimate commercial relations between the countries of the Mediterranean basin are very favourable to the diffusion of plague. It is sometimes stated that there is more danger to Europe from the land route from Bushire which follows the course of the caravans than from the sea route from Egypt, but this opinion appears to be based on an insufficient consideration of the intimate commercial relations which now exist between Egypt and the countries of the Mediterranean. When it was a question as to the possibility of plague spreading from India westwards the condition of the sea traffic between India and Europe rendered it less likely that the disease would spread by sea than by land. The native traders of India and the population of India affected by plague have no direct communication with Egypt or Europe by sea. Hindus are forbidden by the rules of caste to make such a voyage and Mahomedans come only by sea as far as the Hedjaz for purposes

of pilgrimage. The commercial intercourse between India and Europe is maintained by Europeans who belong to a superior class and who have hitherto enjoyed an exceptional immunity from plague. As regards the native crews that are often employed distance and medical inspection exclude any slight danger that might be attached to them. Three cases of plague were imported into London in 1896, but that was before it was known that plague prevailed to any great extent in India. The danger to Egypt of infection by plague has not been in its commercial relations with India, but in its religious pilgrimages which bring its pilgrims in the Hedjaz into very close relationship with Mahomedans from infected centres. But now that plague has arrived in Egypt a goal has been reached which is favourable to its further extension because the conditions of sea traffic between Egypt and Europe are very different from those between India and Europe. There is constant communication kept up by fishermen, traders, and travellers and extending to all classes and including those likely to be affected with the disease. Close proximity also plays an important part.

In the case of a ship coming from India distance gives time for the development of illness on board and allows of the adoption of precautionary measures should it turn out to be plague, but a ship coming from Egypt arrives at its destination in the Mediterranean basin before any signs of illness are manifested. Surveillance on board ship on a voyage of over 10 days is likely to be superior to surveillance on land, especially when the person coming from an infected country has to pass through several countries. It will be seen, therefore, that the plague in Egypt comes under a set of new conditions which are far from being unfavourable to the Westward progress of the disease; nor is this a matter of mere speculation, for it will be remembered that the cholera in England in 1866 and the cholera in Spain in 1884-85 followed its prevalence in Egypt.

As a matter of fact plague has within the last few weeks appeared in Lisbon and Oporto Portugal being a maritime country and in close connexion with Spain the facilities for extension are considerable and the proximity of this new centre adds to the danger. From England Portugal is not more than two or three days' sail, and as there is communication which is not direct with the larger ports where control can be exercised, but with a number of smaller sea-ports where constant supervision is rendered difficult, the

risks to this country are enhanced. The Local Government Board are fully alive to this aspect of the question, as can be seen from their special orders on the subject.

THE BASIS OF PREVENTIVE MEASURES.

Having considered the likelihood of the disease spreading I shall now turn to the precautions against the disease.

Preventive measures must be based on our knowledge of the disease. Fortunately, this has been considerably added to since the plague first broke out in China. Two discoveries of the first magnitude have been made—the one by Kitasato, showing that the bacillus is the cause of the disease; the other by Haffkine, proving that from this bacillus a prophylactic may be prepared which has strong protective powers. These discoveries, combined with the fact that plague is a disease which only slowly gains a firm footing in a locality, render the checking or mitigation of an outbreak much more hopeful and certain than before. The recognition of the bacillus permitted observations to be made as to the manner in which the microbe leaves the body. The bacillus has been found in the excreta, in the urine, and in the sputum. There is a specially dangerous and infective form of the plague termed the “pneumonic” in which the sputum teems with the bacillus. It is therefore the sputum and excretory discharges to which special attention has to be paid. It is by these that the clothes, bedding, and surroundings are likely to become infected.

Precise information of this kind is a considerable advance on that previously known, though it must be admitted that the information does not extend to the life-history of the bacillus in nature or to the exact methods by which the human body becomes infected. All that can be said at present is that water as a vehicle for the multiplication and spread of the disease plays a very unimportant part. Unlike cholera plague on reaching a new locality does not break out suddenly into a large epidemic but extends slowly for some considerable time. A month and, according to Captain Grayfoot, I.M.S., more than six months have frequently elapsed between an imported case and the first indigenous death. The slow progress of the plague in an infected locality, its apparent inability to spread by water, the mortality which usually occurs among rats previously to a general outbreak, and the fact that the bacillus of the

rat plague is identical with the plague bacillus in man have led some observers to think that the extra-corporeal life of the microbe is in the soil, which is an opinion conforming to the Chinese view that the poison of plague is in the soil. Experiment has so far not confirmed this opinion but hitherto researches in this direction have not been numerous. A wide gap accordingly exists between what is known and what is necessary to be known to give us control over plague. The danger of extension, as in some other infectious diseases, lies in our ignorance as to the medium and agents by which the bacillus gains access to the body, and if the bacilli are not destroyed immediately they leave the body the necessary dependence on general rather than on special measures of defence is a defect which may be far-reaching in its results. It is a disadvantage which every opportunity should be taken to remove, and for this purpose it seems to me to be of paramount importance that the Governments of those civilised countries which are affected with plague should not be content in merely endeavouring to combat the disease by every known method at their disposal, such as isolation of the sick, evacuation and disinfection of infected houses, &c., but that they should systematically, as a part of the sanitary defence of the country, establish laboratories and special departments for organised research and inquiry into the mode of spread of the disease, for it is only by the adoption of these methods that success is likely to be attained. Fortunately, owing to the researches of Haffkine in another direction, we are in possession of a prophylactic which if extensively employed will lend powerful assistance to the other measures which may be introduced to control the disease. An agent which almost wherever it has been tried is uniformly successful in reducing the mortality amongst the inoculated when compared with the uninoculated to over 80 per cent. and which has reduced the hospital mortality among the inoculated attacked by 50 per cent. is a most valuable weapon of defence which must, if plague continues to increase, come into more and more requisition. That its value is being recognised outside of India may be gathered from the fact that many applications have already been made for quantities of the prophylactic. Among authorities applying may be mentioned the Governments of the Mauritius, Natal, Italy, and Russia, the Crown Agents for the Gold Coast, the Consul-General of Zanzibar, the Governor of Nicosia, Cyprus, and the Chamber of Mines, Johannesburg.

THE PRECAUTIONS AGAINST IMPORTATION.

To the precautions which were devised by the Venice Conference to prevent importation of plague into a healthy country and which are embodied in the Venice Convention I think it is a subject of consideration whether two others might not be added, both depending on exact knowledge obtained and confirmed since the meeting of the Conference. The first is that use should be made of the protective power of Haffkine's prophylactic, and the second is that rats, as they have been proved to suffer from the same plague as human beings and to be agents in its dissemination, should be dealt with at infected ports and on the voyage on ships from infected ports. As regards merchandise, it has always appeared to me that much of the infection is rather connected with the rats which are to be found accidentally associated with grain and other articles of merchandise than with the merchandise itself, and that special precautions should be taken against this mode of extension of the disease. The practical application of Haffkine's prophylactic to the crews of all ships and boats, large and small, coming from infected ports would probably largely reduce the danger of the importation of plague and relieve the anxiety felt at a healthy port when a ship enters having left an infected port a few days previously. Similarly, under certain circumstances and precautions protection might be given to passengers or travellers desirous of crossing the frontiers into a healthy country.

PRECAUTIONS TO PREVENT SPREAD OF THE DISEASE IN
AN INFECTED COUNTRY.

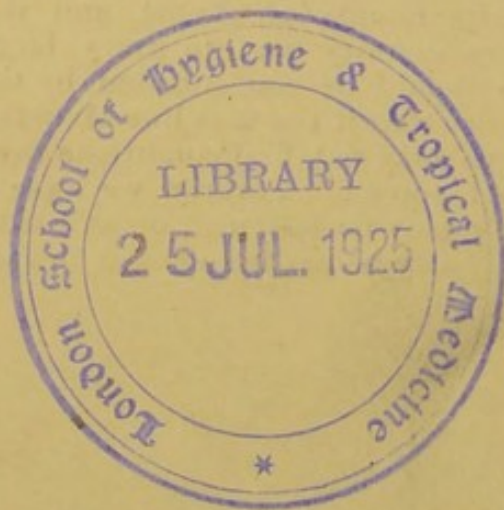
In connexion with the checking or stamping out of plague when it breaks out on land the early notification of diseases is of immense advantage, for it allows measures to be early and promptly applied so that the sick can be isolated, the inmates of the house removed and watched, and the house itself disinfected. For large cities the camping-out system available for villages and small places, and which in these instances has proved so useful, is impracticable, especially if a large area is infected; but in both village and town whenever a case of plague occurs not only should the inmates removed from the infected house be inoculated but also the inhabitants of the houses within a certain area. By the

latter means a zone of comparatively immune persons would occupy what might otherwise become a dangerous focus of disease.

It is possible with proper organisation to deal with an outbreak of plague much in the same way as with an outbreak of small-pox. Large supplies of Haffkine's prophylactic are necessary in order that every possible contingency may be provided for and the preparation of these supplies, which require time and a skilled organisation, ought not to be left to the last moment. To meet plague the organisation for defence requires to be placed on as complete and in as efficient a state of preparedness in every respect as the army and navy of the country would be in if there was danger of invasion.

The sanitary organisation of England inspires confidence that all will be done which our present knowledge suggests to protect the country against disease. But, as stated previously, that knowledge is very imperfect. In the case of an outbreak of disease such as typhoid fever in this country a scientific investigation is undertaken as to its cause and mode of spread. It is known that typhoid fever is caused frequently by contaminated water. This, however, does not prevent further investigation being made in order to ascertain if any new facts can be discovered with reference to the epidemiology of the disease. Epidemic after epidemic is carefully inquired into. A similar inquiry of even a more searching and extensive nature is certainly and most urgently called for in regard to the plague, which is a disease that this generation is not familiar with. The importance to this country of observing its behaviour as notified by conditions in Europe is such that study of it in its epidemiological, prophylactic, and curative aspects should be undertaken by Government. To this end it would appear to me advisable that a small Commission of experts—of physicians, epidemiologists, and bacteriologists—should be sent to the Peninsula for that purpose. It is a matter of Imperial concern and admits of no delay. No expense should be spared, for if the matter is considered from no higher standpoint than a financial one experience has shown that plague wherever it has acquired a firm hold disorganises and paralyses trade to such an extent that the money losses are immense. The quarter of a million lives lost in India show the destructiveness of the disease and the importance of making every effort to learn more about plague with the object of its prevention.

Hitherto I have said nothing as regards general sanitation. That attention to this is necessary goes without saying. While preparing to immunise individuals with Haffkine's prophylactic every endeavour should be made to immunise the locality by sanitary measures. But in this connexion it should be borne in mind that excellent water-supplies are of little protection against plague; and as it has been perhaps to the acquisition of pure water-supplies that the attention of sanitarians has of late been chiefly directed while measures for the dryness and purity of soil have taken but a secondary position, it is therefore to the latter branch of sanitation that I would commend that special attention be paid. Localities in which overcrowding, poverty, and filth exist have always been the favourite haunts of plague, and it is on these localities in every country and in every large town that protective efforts should be concentrated by the authorities concerned, in order that if the first line of defence is broken through the plague may not find conditions favourable to its growth and rapid spread. Poverty we have always with us; overcrowding may be lessened, or at least regulated or watched, and filth may be easily removed and the dirty spots cleansed.



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PLAGUE :

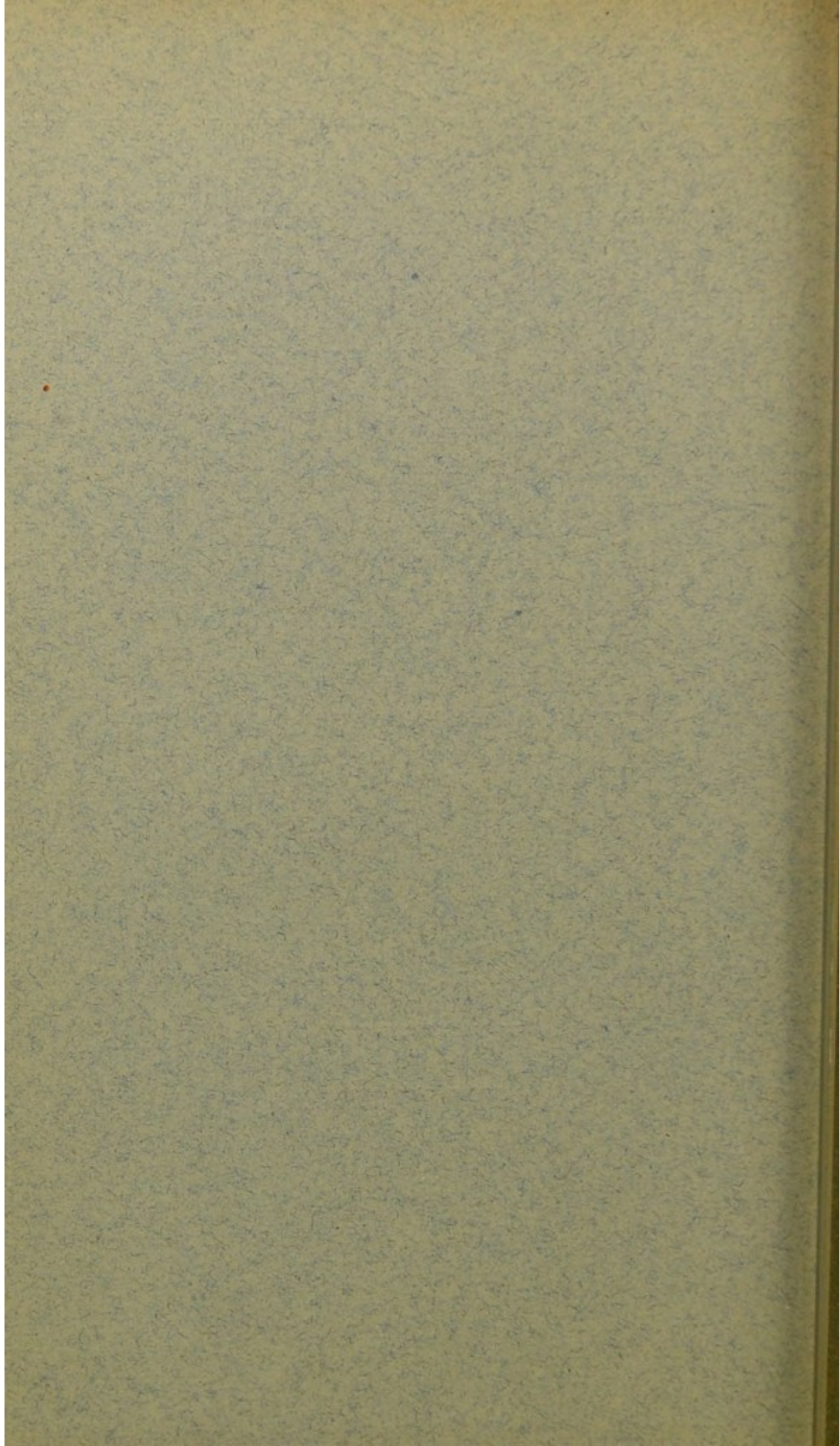
ITS SYMPTOMATOLOGY, PATHOLOGY, TREATMENT,
AND PROPHYLAXIS.



By W. J. SIMPSON, M.D., F.R.C.P.,
Professor of Hygiene, King's College, London.

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PLAGUE :

ITS SYMPTOMATOLOGY, PATHOLOGY, TREATMENT AND PROPHYLAXIS.

INTRODUCTION.

Two features are specially characteristic of plague. They are, first, the slow, irregular, and gradual manner in which the disease acquires a hold over a locality into which it is imported, and which may later on become the scene of an epidemic; and secondly, the obscurity which often surrounds the earlier cases. The first is apt to raise false hopes of the disease dying out, to cause the procrastination of effective measures, and to favour the postponement of careful inquiries into the disease at a stage when its movements and mode of spread are more easily followed than later on. The other gives rise to disputes as to the nature of the disease, and consequently to the loss of valuable time. Much of the obscurity which formerly involved the early cases in a locality is beginning to be cleared away since the discovery of Kitasato's bacillus. When everyone is on the alert as to the probability of plague being one of the diseases which may be met with, the bacillary test is all-important in its usefulness, but when there is no suspicion, there are two varieties which may escape attention for some time, and so permit the germs of the disease to be extensively spread. These are the pneumonic and ambulant varieties.

THE PNEUMONIC FORM OF PLAGUE.

The pneumonic variety, which is very infective, has been demonstrated by Surgeon-Major Childe, I.M.S., to owe its infectivity to the fact that the sputum frequently contains almost a pure culture of plague bacilli, which get on to handkerchiefs, clothing, bedding, and other articles of furniture, as well as on to the floor of the patient's room. This form is particularly dangerous because the clinical symptoms are not typical of ordinary plague, and it is more likely to be mistaken for bronchitis, broncho-pneumonia, or pneumonia. Pain, tenderness, and enlargement of the lymphatic glands in the inguinal, femoral, axillary, and cervical regions, which are the most prominent external signs of bubonic plague, are absent; and beyond cough and fever, and a prostration which is exceptionally severe, and far exceeding that which ought to be expected from the small amount of lung mischief discernible, there are few signs to raise suspicion that the disease is plague. The illness commences with a rigor, and symptoms

of general *malaise*, intense headache, nausea, vomiting, and pain in the limbs and body, followed by fever varying in range from 102° to 105° . Cough more or less pronounced with dyspnoea sets in, and a quantity of watery sputum tinged with blood, and becoming profuse as the disease advances, is coughed up, as a rule, without effort. The sputum has not the glairy, viscid, rusty character of acute pneumonia, though on the clothes it may be readily mistaken for this. Moist sounds are heard at the base of the lungs and over the pneumonic patches; but however hurried the breathing and quick the rate of the pulse, there is not that disproportion between the pulse and respiration ratio which obtains in acute pneumonia. The symptoms become rapidly worse, the patient becomes delirious, there is gradual failure of the heart action with or without coma, and death occurs on the fourth or fifth day, or earlier. This form of plague, besides being the most infectious, is also the most fatal.

THE BACILLARY TEST.

The only certain means of diagnosis during life is to examine the sputum by spreading a small quantity on a cover-glass or slide, drying, fixing, and staining with gentian violet, methylene blue, carbol fuchsin, or any of the ordinary aniline dyes. An examination with one-twelfth oil immersion will decide whether the characteristic cocco-bacilli or diplobacteria, more deeply stained at the ends than in the centre, are present. Should these be found at a time when there is only suspicion of plague existing in a locality, the confirmatory test of cultivating the bacillus should be immediately applied; and, as this cannot be done without a laboratory, the suspected sputum should be placed in a stoppered phial, properly sealed, and taken or sent to the nearest bacteriological laboratory for examination and report.

The most reliable diagnostic test as to whether the diplobacteria are plague microbes is Haffkine's stalactite test. This consists in cultivating the microbe in broth to which drops of clarified butter or cocoa-nut oil have been added. From the drops of oil suspended on the surface of the nutrient medium the bacilli grow down into the depths of the liquid in the form of long threads, producing the appearance of stalactites. When disturbed the threads fall in snow-like flakes to the bottom. This stalactite formation is, under these conditions, peculiar to the growth of the plague microbe, no other microbe having hitherto been found to possess the same property.

THE AMBULANT OR MILD FORM OF PLAGUE.

The ambulant or mild variety of plague, which is a non-fatal form, is even more likely to escape attention than the pneumonic, because of the slight constitutional disturbance which it may produce, and because it is often taken for some other disease. *Pestis minor* or *pestis ambulans* is, if anything, more insidious and dangerous to the community at large than the pneumonic, for its mildness produces no sense of danger. Further, it is not discernibly infectious, the cases appearing to crop up unconnected with one another, and it is generally mistaken for mumps, syphilis, the result of a strain, scrofulous glandular affections, and malarial disease. The clinical symptoms are ill-defined or well-defined fever; pain, tenderness, and enlargement of the lymphatic glands, in the

groin, armpit, or neck; weakness, a tongue which is coated with a creamy white fur in the centre, and is angry and red at the tip and edges; the eyes may be slightly congested and the speech may be a little thick. This is the acute form, which may only last a week, the bubo resolving rapidly or quickly suppurating. In the more chronic form, which may last two or more months, the bubo or buboes are indolent, and they undergo a slow process of suppuration and sloughing, constituting a serious drain on the general health of the patient, producing anæmia and debility. These mild or benign forms of plague have been observed in nearly all plague epidemics; they are described by Sydenham in his observations on the plague of London 1665 and 1666; also by Fodéré in his account of the plague of Marseilles in 1720, and by Forbes in his description of the Pali plague. Again they are noticed in the records of the comparatively recent plagues of Benghazi on the North African coast, of Mesopotamia and of Persia. The most recent example of this form of plague, unmixed with other varieties, was the glandular sickness, as it was called in Astrakhan in 1877. In this city an outbreak which affected more than 200 persons occurred without a single death, and without being followed by the virulent form. Those affected suffered from fever more or less acute, with swellings and inflammation of the lymphatic glands, which in most cases ended in abscesses. Beyond the inconvenience and discomfort caused by the buboes, sometimes in the neck, sometimes in the armpit, and at other times in the groin, the general symptoms were not such as to prevent the patient from moving about. About the same time there prevailed at Resht in Asia Minor, and with which Astrakhan has more or less communication, the same type of glandular sickness along with a severe type of plague. In the next year—in 1878—the glandular sickness of Astrakhan appeared at Vetlianka, a village on the banks of the Volga, and some distance from Astrakhan; but in a short time it was succeeded by a most virulent type of plague, which assumed the pneumonic form, and was of an extremely infectious and fatal character. The mortality at the height of the epidemic was 100 per cent. Mild cases of plague were observed in Calcutta, Bombay, and Alexandria long before the fatal cases attracted attention, and apparently these mild cases have also occurred in Oporto, for a peculiar type of fever with swellings is reported to have been noticed in that city for some time. This mild form is only distinguished by a careful inquiry into the history of the case, and by a process of elimination. In Calcutta examination of the blood from the affected gland showed in some cases the characteristic bacillus, but in others none could be detected.

It is evident that this form of the disease requires special and further investigation. The elucidation of *pestis ambulans* is of the greatest importance from an epidemiological point of view. The fatal forms of plague cause alarm, and are likely to be met by stringent effective measures of control; but the milder forms are almost certain to be overlooked or considered to be unimportant, and in the meantime the disease gains a firmer hold on the locality, and may later develop into a more virulent type.

It is too frequently assumed that the milder forms are not communicable. This is an assumption which has gained

ground of late owing to the supposed imprisonment of the bacilli within the infected glands, strengthened by the difficulty in connecting one mild case of plague with another. It is a pretty theory, but against this is the fact that mild cases continue to spread, and that no systematic inquiry has ever been made into their mode of spread.

THE BUBONIC FORM OF PLAGUE.

The bubonic variety of plague, as its name implies, is always accompanied by buboes, which usually appear at the commencement of the illness in the groin, armpit, or neck, and occasionally in the supratrochlear or popliteal space. The most common site is the groin, and the next is the armpit; but more than one region may be affected, and often groups of neighbouring glands on the same course of lymphatics become infected. The bubo varies in size, and is, as a rule, extremely tender and exquisitely painful. In cases which prove fatal early the glands may remain hard and painful, but in the majority, owing to the matting together of glands by a serous and sanguinolent infiltration, and by a mass of extravasated blood, the bubo enlarges and forms a doughy and bulky swelling. At times, owing to pressure on veins, a considerable amount of oedema of the tissues in the neighbourhood of the bubo occurs. The size of the bubo is not of so much importance as its position. When situated in the axilla or in the cervical region it is particularly dangerous when the exudation is extensive, because the effusion is apt to become organised and converted into a hard mass, which may press on some vital part, or may form a large slough. If the patient lives for seven or eight days the bubo either begins to resolve, or shows signs of softening and goes on to suppuration or to suppuration and sloughing. Examination of the lymph and blood of the glands and buboes show large numbers of the plague bacilli. A gland or bubo may be punctured, and a small quantity of the contents drawn off by suction with a sterilised pipette, closed at one end to protect the operator against accidental infection.

There are certain symptoms common to all forms of plague of the severer type: these are the peculiar expression of the face, the halting speech, and the appearance of the tongue. The countenance generally portrays in the early stages anxiety and distress, later resignation and apathy; the eyes are red and congested, and the patient has the appearance of being under the influence of a hypnotic, and yet unable to sleep, the eyes remaining wide open. Unless delirious when the face is flushed and the physiognomy wild, the expression in advanced cases is apathetic or vacant, masking the approaching dissolution. The speech is peculiarly hesitating and broken, being more or less staccato in character, each syllable being pronounced by itself in a thick and husky tone like that of a drunken man, or only half the sentence may be spoken, the rest being forgotten. The tongue is early coated with a creamy white fur, except the tip and edges, which are clean and red; later it is dry, covered with a yellowish or whitish-brown fur, the tips and edges remaining red and irritable.

The characteristic physiognomy, speech, and tongue with the presence of a bubo are unmistakable signs of plague. The general symptoms of a typical case are shivering, high fever, nausea, vomiting, intense general or frontal headache,

painful and tender bubo, staggering gait, suffused and congested eyes, anxious expression, coated tongue except on tip and edges, restlessness with uncontrollable desire to wander aimlessly to some distant locality, dyspnoea, increasing disturbance of the nervous and circulatory systems, manifesting itself in high and noisy delirium or coma, and in gradual or sudden failure of the heart's action. The pulse, which is quite soft and easily compressible at the onset, becomes intermittent and dicrotic and often difficult to count, and there is a tendency to collapse, the patient's extremities becoming cold and clammy. After the sixth or seventh day the patient's chances of recovery are much increased, and the temperature usually reaches the normal about the tenth day.

THE SEPTIC VARIETY OF PLAGUE.

The septic variety of plague is a virulent type in which the lymphatic glands show no special enlargement during life, and consequently the bubo is absent, but after death the glands are found to be generally affected, being somewhat enlarged and much congested. In this form of plague the bacilli early invade the blood in large numbers, and are easily detected. The chief characteristic is its rapidity. The patient is profoundly affected by the amount and strength of the poison received. Usually ushered in with high fever, there is at times no power in the patient for reaction, and the temperature does not reach 100° F. The countenance is pale, and the expression apathetic. Extreme nervous prostration, muscular weakness, delirium, picking of the bedclothes, stupor, and coma follow quickly on one another, and the patient dies on the first, second, or third day. In these cases there may be bleeding from the nose, kidneys, and bowels.

POST-MORTEM APPEARANCES.

The characteristic appearance in a necropsy of plague is that of engorgement and hæmorrhage, nearly every organ of the body participating more or less; there is also parenchymatous degeneration and change in the heart, liver, spleen, and kidneys. The bubo consists of a number of congested glands embedded in a mass of extravasated blood, with extensive exudation into the adjoining areolar tissue, the larger blood vessels being often involved. The glands in the bubo are swollen, vary in size from a bean to a walnut, and when cut into are found to be much congested and of a dark-purplish colour. In the septicæmic and pneumonic form, in which the bubo is absent, nearly all the lymphatic glands are slightly enlarged, pink or dark-red in colour, and some may be engorged. In the pneumonic there is, in addition to the general engorgement of the lungs, several pneumonic patches. Plague bacilli are to be found in the different varieties in the lymphatic glands, and the serous or sanguinolent exudation around them, in the blood, spleen, lungs, liver, bile, urine, peritoneal fluid, and fluid of the brain. It is obvious that, with so general a distribution in the corpse, the danger of some of these bacilli escaping and finding a lodgment in a favourable medium for their multiplication is not inconsiderable, and that the greatest care is needed to prevent this.

TREATMENT.

Curative treatment has but a small share in lessening the general mortality of plague, which ranges between 60 and 90

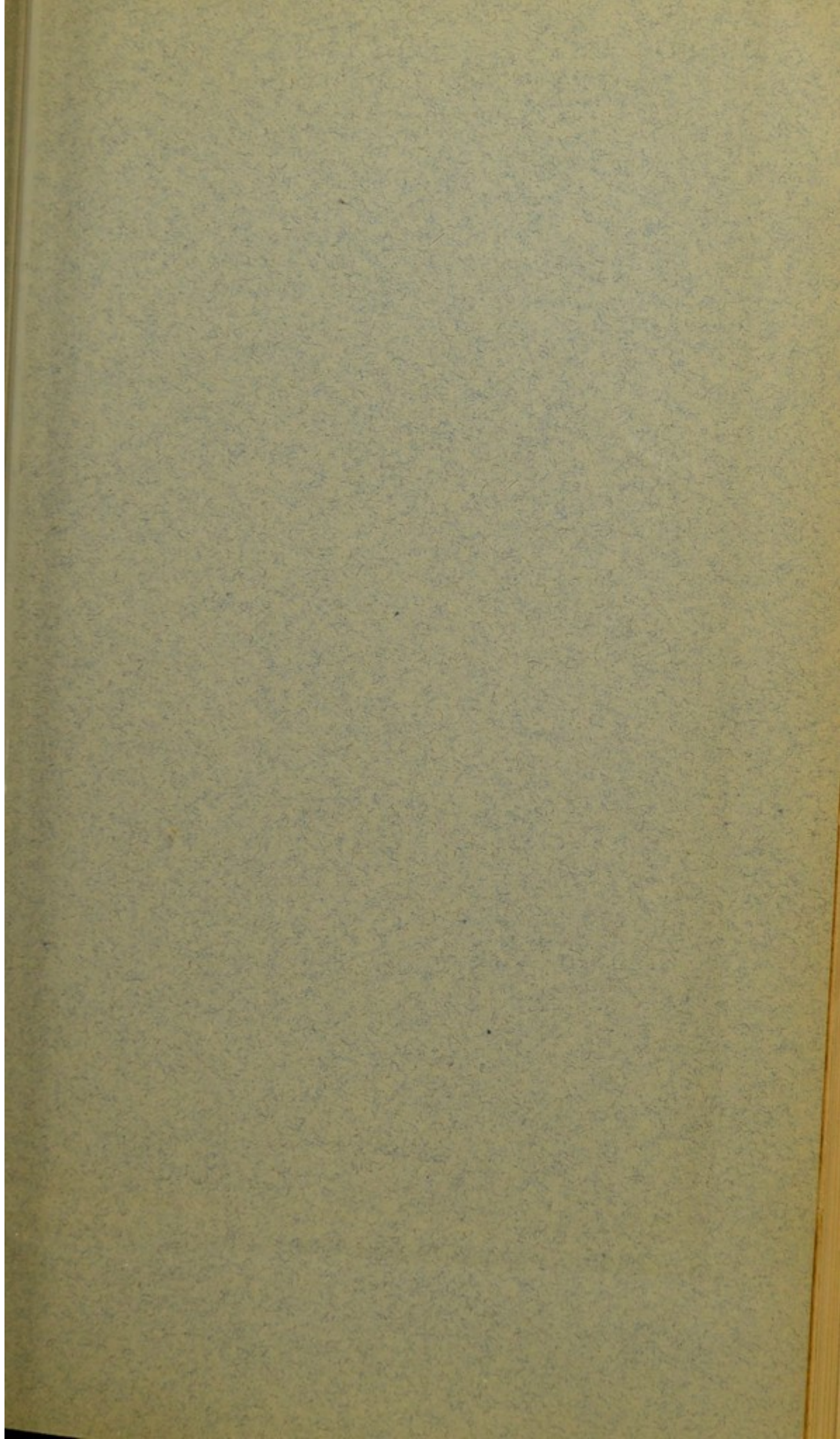
per cent. The antitoxin treatment has hitherto practically failed. The hopes that were raised by the success following the employment of Yersin's serum in a few cases in China have not been borne out when applied on a larger scale in India, nor has any greater success attended the employment of Lustig's or Roux's serum. In the treatment of plague all that can be done is to secure the best conditions in order that the patient may make a good fight against the disease, and these consist of good nursing, early confinement to bed, the maintenance of the recumbent position to prevent syncope, careful feeding, and general treatment to keep up the patient's strength and prevent complications if possible. To control the febrile symptoms and check delirium, ice bags to the head and sponging of the body and the use of hypnotics and sedatives which are not depressants have been found to be beneficial. To sustain the action of the heart alcoholic stimulants, ammonia, strychnine, and digitalis have been freely employed. Complications are treated on general principles as they arise. The pain and tenderness of buboes are much relieved by the application of the ice bag, which has also a good effect on the infiltration. Other applications, such as glycerine and belladonna and poultices have been practised. The bubo is opened when pus forms, but nothing is gained by too early incisions.

PRECAUTIONS.

As soon as plague is suspected or diagnosed, the case should be notified to the local authorities, with whom rests the responsibility for carrying out the necessary measures to prevent the spread of the disease; but medical men and nurses can materially assist the authorities in this respect, and prevent the disease from spreading in the family or infecting themselves. For this purpose, until the local authorities can take action, or if the circumstances of the patient do not permit of removal, the patient should be strictly isolated in the most secluded and best ventilated room in the house. An acid solution of perchloride of mercury, of the strength of 1 in 500, should be obtained at once. Sputum, urine, and excreta should be received in vessels containing perchloride of mercury of this strength, while a solution of half this strength may be used in vessels for soaking soiled clothes, disinfecting cups and spoons, etc., or washing the doctors' and nurses' hands after handling the patient.

Nothing from the patient should be discharged down the drain without being thoroughly mixed with an abundant quantity of this disinfectant, otherwise rats in the sewers may become infected and carry the disease elsewhere. In the event of death a sheet soaked in the strong perchloride solution should be wrapped around the body and earbolised sawdust should be put into the coffin. Nurses, doctor, and the inmates of the house should be inoculated with Haffkiné's prophylactic. Under ordinary hygienic conditions and with ordinary precautions there is no danger to a doctor or nurse attending a plague patient. I have not entered into the precautions which the local authority are likely to take, for these do not come within the scope of this paper.

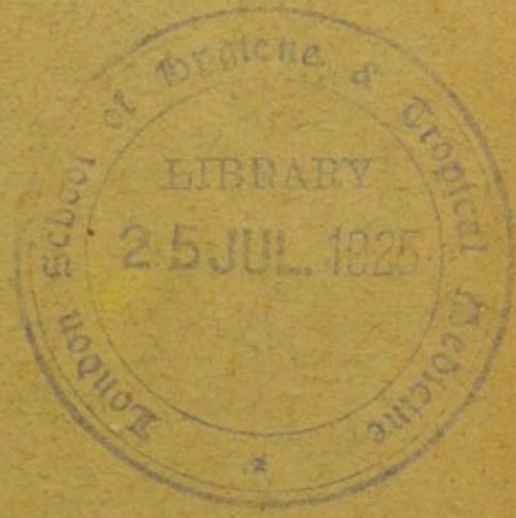






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PLAGUE VIEWED FROM
SEVERAL ASPECTS

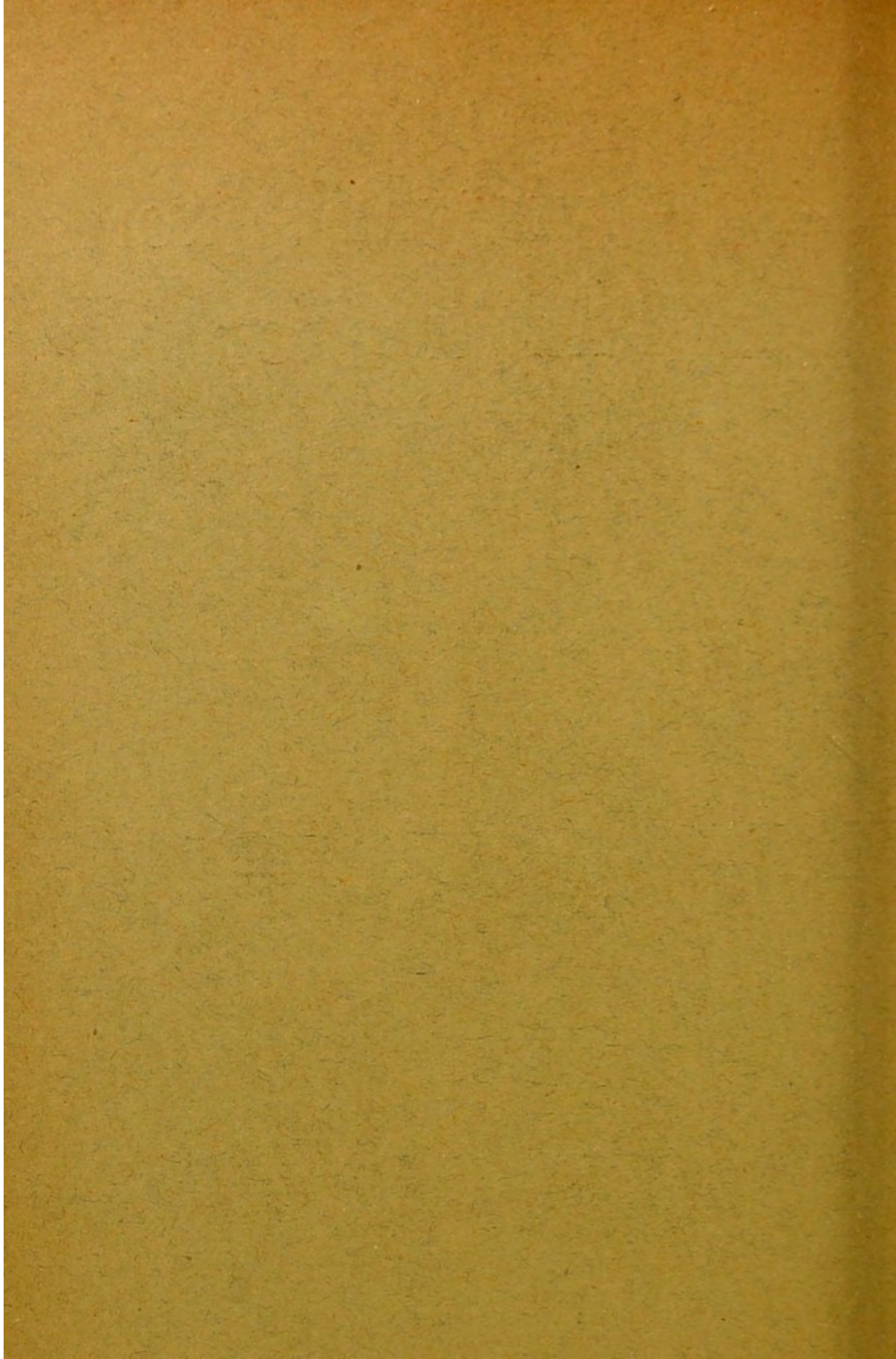


BY

V. J. SIMPSON, M.D. ABERD., F.R.C.P. LOND.

PROFESSOR OF HYGIENE, KING'S COLLEGE, LONDON.

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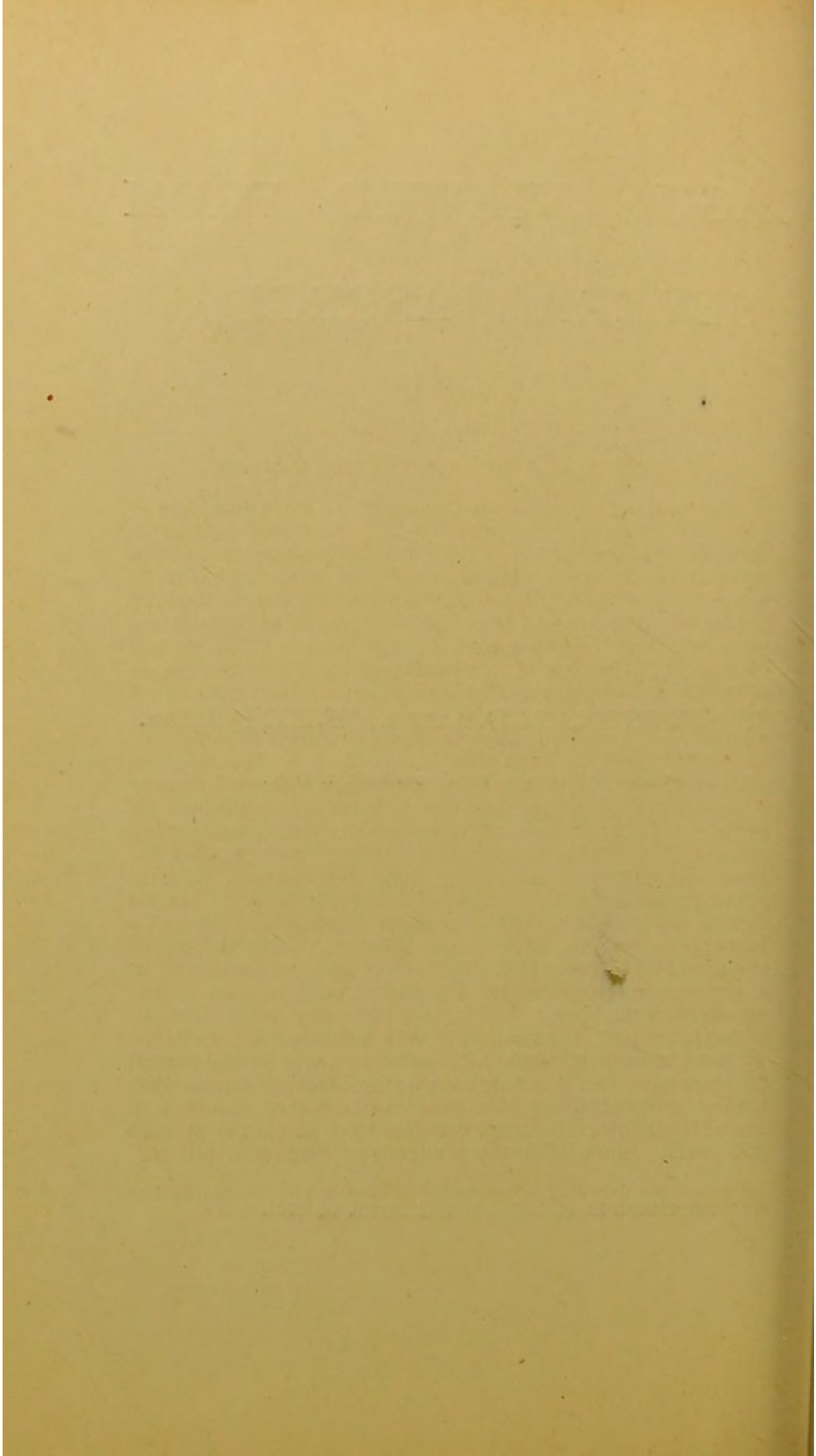
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PLAGUE VIEWED FROM SEVERAL ASPECTS.¹

PANDEMIC PLAGUE AND ENDEMIC CENTRES.

SIX years ago plague was regarded as a disease only of historical interest. Its presence in one or two centres in Persia, India, Arabia, and China was not considered to be of much importance, its continuance there being attributed in the main to the filthy condition under which the inhabitants dwelt, which prevented the disease from being completely stamped out. This view took no cognisance of the natural history of plague, or of the rarity of an epidemic disease completely disappearing from every part of the world, or of the existence of other factors besides ordinary sanitary conditions which periodically in the ages give to epidemic diseases a fresh impetus that brings them to the front as active agents. If we are to be guided by historical records it is clear that plague has always been characterised by periods of activity and of quiescence, often disappearing completely from the countries in which it has prevailed for years and not re-appearing for long intervals and then re-appearing in a pandemic form. The last pandemic of plague was in full activity in the seventeenth century and covered a large portion of Asia, Africa, and Europe. Towards the end of the seventeenth century it began to retire and continued in a state of retrocession for 150 years, until in 1845 it disappeared from Egypt which had for many years been an endemic centre. Its cessation in such a centre was considered by some to be a triumph for sanitary science as understood 50 years ago; but it is now known from Arabian sources that similar disappearances have taken place before and that in one of these intervals Egypt was free from plague for at least 300 years. Since 1850 the tendency of plague to fall still

¹ An address delivered before the South-West London Medical Society on March 14th, 1900.

lower in the pandemic or epidemic scale has been arrested, and there has been a visible recrudescence, as manifested in the local outbreaks a little over 20 years ago in Asia Minor and on the Volga, and in the extension of plague from Yunnan to Pakhoi about the same time. It is due to these smaller recrudescences that we have become familiar with the old and new endemic centres in Arabia, in Mesopotamia, in Benghasi in Northern Africa, in Ghurwal and Kumaon in India, and in Yunnan in China. It is a remarkable fact, however, that the more the records of plague are studied the more these endemic centres recede and the more certain it becomes that "endemic centre" is only a relative term. There are, so far as can be made out, no permanent homes of plague. Even in Irak in Mesopotamia, the oldest and most permanent home we are acquainted with, plague disappeared for 75 years during the Abbasidic dynasty, and later for 100 years. There are no restricted localities where it can be said that plague has always and perennially existed. The endemic centres shift from one locality to another. Sometimes they are in the highlands and at others in the lowlands. On the strength of plague being endemic in Egypt and Mesopotamia for so many centuries the theory was held that plague took its origin in the low-lying marshes and inundated lands of these countries and that these were the conditions necessary for its annual reproduction. To-day this can be no longer exclusively held, for the present endemic centres of plague are in the highlands of Arabia, India, and China.

The Chinese endemic centre in Yunnan, from which the present pandemic is derived, is between 5000 and 7000 feet high. It has been known as an endemic centre of plague since 1870, but there are Chinese records which seem to indicate that the disease probably existed there over 100 years ago, for mention is made in the last years of last century of a strange and fatal rat disease occurring which also affected the inhabitants. There are no records discovered which make the endemic centre older than this, and there is no evidence to show that the Black Death of 1348 arose from Yunnan. M. Rocher, who first drew attention to Yunnan as an endemic centre of plague, is of opinion that it was first introduced before 1840 by Mohammedan pilgrims returning by Burmah from the Hedjaz, and that it has continued to be endemic in that province since. A notable fact connected with this centre is that notwithstanding the backward condition of sanitation in China the

tendency of plague to spread from Yunnan has been so slight, even in the presence of a large rebellion in the province, that it has taken more than 50 years to pass from Yunnan to Canton, a distance of not more than 1000 miles. For several years previously to its arrival in Canton it had spread to smaller towns but had never assumed any large epidemic proportions. In 1894, however, the disease obtained a thorough hold of Canton and destroyed in a short time 80,000 of its inhabitants out of 1,000,000. Since 1894 plague has prevailed more or less in Northern and Southern China, Formosa, Japan, India, the Philippines, Honolulu, the Mauritius, Jeddah, Alexandria, and Oporto, and has made its appearance in Southern and Central America, on the eastern coast of South Africa, and in Australia. True, it is only in India, China, Formosa, and the Mauritius that plague has assumed an epidemic form of any dimensions, but its expansion over different parts of the world is a fact the significance of which has to be carefully considered and the importance of which is not to be minimised by its apparent powerlessness to cause a destructive epidemic. The general mildness and circumscribed limitations of the indigenous cases which have sprung up outside Asia in those places into which plague has been imported tend to give rise to the impression that the plague no longer possesses, except among Asiatic races, its power of mischief, but against this is to be pointed out the fact that, with the exception of the Black Death in the fourteenth century the ordinary behaviour of plague in new localities is slow and insidious, and that its hold on a locality is not necessarily to be measured by the effect produced on its first arrival or even on its second or third manifestation. We have a good illustration of this in Calcutta, in which plague cases have existed on and off since 1896, and it is only now in 1900 that the cases are beginning to assume higher proportions. The Great Plague of London, again, was but the culminating stage of several previous epidemics occurring at various intervals of time over some 70 years, none of which were free from a few cases of plague. As in a localised epidemic, even when severe, the disease is noticed to confine its energy in the early stages to a small portion of a city and but slightly to affect districts distant from this centre until a considerable time has elapsed or perhaps not until the plague has disappeared altogether from the locality first affected, so also plague in its epidemic or pandemic form sometimes advances in a similarly halting fashion, acquiring

slowly and gradually a sure foundation for its future progress wherever conditions exist favourable to its development.

SOME CAUSES OF OBSCURITY AS REGARDS MODE OF
EXTENSION.

Modern systems of rapid communication by which intelligence of events occurring in different parts of the world become quickly known, combined with a more accurate knowledge of the disease, place us to-day in a much more advantageous position for watching the broadcast sowing of the seed preparatory to its ripening than was possible in the olden days, and probably it is to the absence of this means of intelligence in past times that so much confusion arose regarding the sources and origin of epidemics. But even with the advantages named it is a curious fact that the manner in which a locality becomes infected can seldom be determined, and in the investigations which have been carried out to decide this question the cases which were supposed to be the first are almost invariably found to be preceded by other cases until the record goes back to a time when nothing can be definitely settled. Bombay, Alexandria, and Oporto are examples. There can be no doubt that the disease was imported into these towns, but when and in what way are unknown. Conjecture has always to fill up the gap unless in those exceptional cases in which the imported disease catches on immediately. Investigation on systematic lines will alone clear up satisfactorily these obscurities. In the meantime the mystery attaching to the origin of plague in many localities may be partly explained by the fact that until recently the various types of plague were not clearly defined and consequently easily escaped recognition, and partly to the fact that the disease is disseminated by animals, especially rats. These are factors which certainly play an important rôle in the spread of this insidious disease.

Of the varieties of plague the ambulant, the fulminating, and the pneumonic are the most difficult to diagnose. The ambulant is apt to be overlooked because of the mildness of the symptoms. There are slight fever, malaise, headache, congested eyes, and a glandular swelling, but the sickness is often short in duration and does not attract any particular attention. The fulminating type and the pneumonic type are severe and fatal forms of plague, often without buboes, and

are specially likely to be taken for other diseases, the latter being mistaken for some severe affection of the lungs. An acquaintance with the fact that there are different types of plague does not assist to any great extent unless these types are diagnosed when met with and it must be confessed that owing to the deceptive characters which they assume there is great risk of them being not recognised.

The importance of the dissemination of plague by rats is only gradually being appreciated. It is a well-attested fact and has in numerous localities been the precursor of an extensive outbreak. The rat plague is also slow in its progress and it must not be imagined that it is just previously to the rats dying in their hundreds and thousands that plague is imported into the locality; the origin has to be sought at a much earlier period when mortality occurs only among one or more rats in groups. It was a well-known fact among the ancient Hindoos that when rats began to die in a house it was time for the inmates to leave their abode. Rats when they sicken with plague leave their holes and come out into the open. They look ill and are in a dazed condition, their eyes are watery and bleary, their coats are partially deprived of hair, and they hobble about with difficulty and stagger and fall. They make very little attempt to escape when approached and their behaviour is so extraordinarily different from what is usual that the illness from which they are suffering may be at once suspected. The glands of plague-infected rats are enlarged and these, together with the internal organs and blood, contain plague bacilli. It is not safe to handle rats which are either suffering, or have recently died, from plague.

It has been a decided advance in our knowledge to learn that there are varieties of plague, that they are not easily recognised, and that rats are susceptible to plague and are disseminators of it, and the want of that knowledge accounts in no small measure for the frequent failure to determine precisely either the means by which, or the time at which, plague is introduced into a locality. Plague has often been connected with the corn ships of an infected country reaching a healthy port. When not brought by infected men or their personal effects there can be but little doubt that the infection was not in the corn but in the rats amongst the corn.

SPECIAL DANGER TO OTHER COUNTRIES DURING THE
EARLY AND LATE STAGES OF AN EPIDEMIC.

Great importance has always been attached to the danger of the extension of plague when a town is in the throes of an epidemic, but probably there is more danger to countries communicating by sea with an infected port at the beginning or decline of an epidemic than when it is at its height and everyone is in a state of alarm and strict precautions are taken both at the infected port and the healthy port. In the early stages, while there is no suspicion of the disease existing, the infection may readily be transported to other countries, and it depends on whether the imported cases are at once recognised or not as to the disease having a chance of being disseminated. In September, 1896, two cases of plague occurred at the London Docks in ships that left India before plague was even suspected to exist in that country. Early recognition prevented extension. Let us suppose for a moment that the disease had not been recognised and, having found a favourable soil, had spread; then the simultaneous or almost simultaneous appearance of plague in London and Bombay would have perplexed everyone. In 1899 three cases of plague occurred in Asunción in Paraguay among Portuguese sailors who arrived from Oporto nearly two months before the disease was suspected to exist in Portugal. The disease was not recognised as plague, and if suspicion had not been aroused that one of the cases was yellow fever, for which the authorities were at that time on the watch as it was present in Buenos Ayres, the two deaths would have passed unnoticed and the clue to subsequent events would have been lost. As these cases are interesting from a diagnostic point of view and illustrate the ease with which a centre of infection can be established, I shall give a short account of them.

The first case at Asunción showed a glandular enlargement and some obscure lung affection, death being attributed to disease of the lungs. The second case showed symptoms believed by one medical man to be those of acute gastritis and by another to be those of a general infection, possibly yellow fever. It was because of this latter opinion that several distinguished physicians were sent to attend the post-mortem examination in order to decide the question, as it was of importance that if the disease were yellow fever precautionary measures to prevent

its spread should be immediately adopted. The necropsy revealed general congestion of the internal organs, hæmorrhagic swellings in the spleen, an enlarged liver, and an acute gastro-enteritis. The conclusion arrived at was that it was not a case of yellow fever. No one, however, suspected plague, which was unknown in America and which was not known to be nearer than Egypt. The third case, which came off the same ship, was that of a sailor who went to a small village at some distance from Asunción. He was taken ill there and five months afterwards, on his return to Asunción, he was found on examination to have the signs still upon him of buboes characteristic of plague. The three cases are excellent examples of the uncertainty of the diagnosis of plague when no suspicion of plague is in the mind of the medical man. The true significance of these cases in Asunción was not realised until five months afterwards and then only when a new disease, distinguished by symptoms resembling typhus fever, meningitis, and pneumonia, and frequently accompanied by glandular enlargements in the groin, axilla, or neck, had appeared and prevailed, first of all in a sporadic form in the town for about two months, and later in an epidemic form in the barracks. Only gradually was the suspicion aroused that the disease might be plague, and once that suspicion became general, the discovery, isolation, and culture of the plague bacillus, the classical symptoms of plague which many of the cases presented, and the no less characteristic anatomical features which were observed at the post-mortem examination cleared away every possible doubt. In an investigation which followed this discovery no difficulty was experienced in tracing the new disease back to its commencement; nor was there any difficulty in recognising the symptoms and post-mortem appearances which had perplexed the medical men six months previously as belonging to true cases of plague though the cases appeared at a time when plague in Oporto, where they came from, was not even suspected to exist.

THE IMPORTANCE OF THE ASUNCIÓN OUTBREAK.

Even when plague has acquired a firm hold on a locality it is almost impossible to prognosticate its course. Local outbreaks vary exceedingly in their intensity and extent. They may be rapidly spreading and fatal, or they may be exceedingly slow in their extension, and they may be deadly

or benign in their character. In Canton the disease rapidly spread, destroyed a large number of the inhabitants in about seven months, and then declined, not to re-appear in the following years. In Bombay it has continued year after year in a less intense form than in Canton, but has managed to destroy nearly as many inhabitants. In Calcutta it has been comparatively mild but is slowly becoming more intense. In Jeddah, Alexandria, and Oporto the first outbreak has been extremely limited in its nature. In Asunción plague never assumed the dimensions of a large epidemic. 300 deaths in all would probably cover the extent of the outbreak, and it has been of a mild nature, many of the cases being of the ambulant form, with simple glandular enlargement and no serious illness. Even the severe cases did not present a higher mortality than 50 per cent., which contrasts favourably with the mortality in India and China of 80 per cent. The importance of the outbreak of plague at Asunción does not consist in the small mortality and comparative insignificance of the numbers attacked, but in the fact that plague has acquired in this locality a centre for its diffusion to other parts of the American continent. The disease has spread without hindrance to Buenos Ayres, to Santos, to Rosario, and to Central America, and the outlook is serious because a continent never known to have been visited by plague is now infected in several localities. Nor is it likely that the infection will be limited even to America, for the infected ports in that country are now a fresh source of danger to other parts of the world, as evidenced by the recent occurrence of plague at Cape Town on board of a vessel recently arrived from Rosario.

THE DIAGNOSIS OF PLAGUE.

As previously stated the difficulty of diagnosis of plague arises from the several types and forms which it assumes, and unless the medical man is on the alert for plague and is fully conversant with the types the disease may easily at the commencement escape attention. In Bombay some of the earlier cases, with swollen cervical glands and throat symptoms, were mistaken for diphtheria. In Jeddah, where lung symptoms predominated, the earlier cases were taken for influenza; and in Calcutta, where the ambulant or mild form with buboes occurred, some of them were attributed to syphilis, others to non-venereal buboes or malaria, and others to injury due to a strain or accident. It will thus be evident

that a disease which may be mistaken for yellow fever, gastro-enteritis, typhus fever, diphtheria, influenza, syphilis, malaria, and parotitis is one in which diagnosis from clinical symptoms alone is by no means easy.

The two most perplexing forms of plague are the ambulant and the pneumonic. The ordinary bubonic form has, as a rule, very characteristic symptoms. There are certain symptoms which are common to all severe forms of plague. These are the peculiar expression of the face, the halting speech, the appearance of the tongue, and the staggering gait. The countenance in the early stages depicts anxiety and distress, in the later stages resignation and apathy. When delirium is present the expression may be one of terror. The eyes are red and congested, the conjunctivæ being injected, but there is no photophobia. The patient has the appearance of being under the influence of a hypnotic, yet he is awake with eyes wide open. The speech is stuttering, quick, lisping, and indistinct, often like that of a drunken man. When spoken to the patient often begins a sentence and forgets to finish it. The tongue is early coated with a whitish fur except at the tip and the edges, which are irritable and red. The gait is staggering, sometimes like that of a drunken man, and owing to giddiness there is a great tendency for the patient to fall. From this description it will not be surprising to hear that on occasions an individual with plague has been mistaken for a drunkard and has fallen into the hands of the police. In many plague patients there is a desire to wander and there is great difficulty in keeping them in bed. This desire to wander is attended with great danger to the patient owing to the condition of the heart causing a faint which may never be recovered from.

When fever and the peculiar physiognomy, hesitating speech, staggering gait, and condition of the tongue are met with an examination should be made for the presence of buboes or of lung disease and these should be supplemented by an examination of buboes, blood, and sputum for bacilli. The ordinary bubonic plague is unlikely to be confused with other diseases, the symptoms being well defined. There may or may not be any premonitory symptoms such as malaise and rigors. It most usually begins with sudden fever, rising to 103° F., to 104° , or even to 105° , with nausea, vomiting, and severe and intense headache, mostly frontal and occipital in its seat. The eyes are suffused and congested, there is great giddiness, and the tongue is furred, except at the tip and at the edges. None of these symptoms dis-

tinguish it specially from the onset of some other acute infections, but contemporaneously with the fever, or soon after its appearance, intense pain is felt in the groin, the armpit, or the neck, and at the seat of the pain one or more of the glands will be noticed to be swollen and to be particularly painful on pressure. In the course of 12 hours or even in a shorter time the swelling rapidly increases in size, caused by a periglandular effusion which may be very profuse or only moderate in extent, and the bubo which is thus formed is somewhat doughy to the touch on the surface and of a hard consistence in the deeper tissues. This bubo, with the other signs, is pathognomonic of plague. It is filled with plague bacilli. The bubo varies in size and consists of one or more inflamed lymphatic glands from which exudes a sero-sanguinolent effusion which mats together the neighbouring glands into a hard mass and infiltrates the tissues around, rendering them firm and œdematous. The œdema may be scanty or profuse and in the cervical region it may be so great as to be a serious danger to the patient, and by pressure produce stridulant respiration. In the groin the bubo may reach the size of a man's fist and may extend into the iliac region, affecting the chain of glands in the abdominal cavity and forming a hard tumour to be felt through the abdominal wall. In the axilla the bubo often occludes the axillary space, and the infiltration may become so extensive and organised as to form a hard mass which may interfere with the respiratory movements or become a dangerous slough. The position in bed is always one which tends to relieve as much as possible any tension on the bubo. Ordinarily consciousness is retained, but even apparently with the most perfect consciousness the intellect seems slow in answering questions, the words or sentences being articulated in a hesitating manner, each syllable being pronounced slowly or the speech is staccato in character and uttered in a hurried and irritable tone. The temperature is not characteristic. It may reach its maximum in a day or two or not until the fourth day. It is of a remittent nature and in favourable cases begins to decline on the sixth and seventh day and reaches the normal on the tenth day. The symptoms usually attain their height on the fourth day. Restlessness, with desire to get out of bed and wander, is often a prominent symptom. Dyspnoea and delirium of a quiet or a noisy nature set in, followed in unfavourable cases by coma and gradual or sudden failure of the heart's action.

the pulse, which is soft and easily compressible at the outset, becomes intermittent and dicrotic and often difficult to count, and the patient's extremities become cold and clammy. Recovery usually sets in about the sixth or seventh day, but no prognosis is safe in the early days of illness. The bubo resolves or more frequently suppurates. By puncturing the bubo even at its earliest stage a small quantity of the gelatinous contents can be sucked out with a sterilised glass pipette guarded at the mouth end by sterilised cotton-wool. If the contents so obtained are then spread out on a glass slide or cover-glass, gently heated as in the ordinary preparation of a microscopical specimen, coloured with carbolfuchsin or gentian violet, and then examined by a $\frac{1}{2}$ th oil immersion lens, the field will be seen to be covered with cocco-bacilli or diplo-bacteria, large numbers of them being more deeply stained at the ends than in the centre. No other disease with swollen lymphatic glands presents microbes such as these. Their presence is sufficient to arouse the greatest suspicion at any time, and the material ought at once to be taken to a laboratory where the bacilli can be cultivated and the confirmatory tests applied. When plague is known to prevail in a country the discovery of bacilli by microscopical examination, combined with the clinical features, is sufficient to make the diagnosis of plague a certainty.

In the fulminating, septic, and pneumonic types of the disease in which no buboes may be found, an examination of the blood and sputum for the characteristic bacilli is the chief diagnostic test. In the septic type the bacilli early invade the blood and the patient is prostrated with the intensity and amount of the poison which has penetrated into the system. Besides the common symptoms belonging to all forms of plague this type is characterised by a pallid and sthenic expression and a rapid setting in of extreme nervous prostration, delirium, coma, and death, the patient often suffering from hæmorrhages from the nose, kidneys, or vessels. In the pneumonic type the bacilli are to be detected in the sputum, the disease localising itself at first in the lungs. The symptoms are those of a broncho-pneumonia with much greater prostration. Dyspnoea, cough, and expectoration of a watery fluid tinged with blood are the chief clinical features. The physical signs are moist sounds at the base of the lungs, and the pulse and respiration are rapid, but there is not the same disproportion in their ratios as is observed in acute pneumonia. The patient usually dies on

the fourth or fifth day. This type is the most infectious, the sputum teeming with the bacilli; it corresponds with the Black Death of 1348.

The post-mortem characters of all varieties of plague are distinguished by congestions and by small and large hæmorrhages of the internal organs and venous system, and by the presence of plague bacilli in the enlarged lymphatic glands and the serous or sanguinolent exudation around them, in the blood, spleen, liver, bile, urine, peritoneal fluid, and fluid of the brain. It is this universality of the plague bacillus which causes the corpses of persons who have died from this disease to be dangerous and renders it imperative that special precautions shall be taken immediately death takes place to prevent the spread of the infection. A sheet dipped in corrosive sublimate of the strength of 1 in 500 should be wrapped round the body.

THE TREATMENT OF PLAGUE.

A plague epidemic soon dispels any faith in the old methods of curative treatment. Good nursing and stimulants will do much for the patient, but the struggle is between the natural powers of the patient and the weakness or virulence of the microbe. Neutralisation of the toxin and destruction of the plague bacillus without harm to the patient are the rational objects to be aimed at in treating a plague patient and these are not attained by any of the ordinary pharmacopœial drugs. The only known method attempting to deal with the problem is serum-therapy and though Yersin's serum has fallen into disrepute since its failure, or comparative failure, in Bombay yet it appears to me that it is on that system, or some allied system, that we may hope to make any advance in the treatment of plague. An explanation of the success of Yersin's serum in the few cases in China, where in 21 cases it gave a mortality of 7 per cent., and its failure in Bombay may possibly be due to the different methods employed in the preparation of the Chinese serum and the Bombay serum. At least that is the view of the Pasteur Institute and until it is otherwise proven may, I think, be accepted. The Chinese serum was obtained from the horse by injecting it with living and virulent cultures of the plague microbes, but owing to the dangers attendant on this method the Bombay serum was prepared by injecting dead cultures. Of late a return in part to the original

method of preparation has been made and the serum as now supplied from the Pasteur laboratory is obtained by injecting horses, first of all with dead cultures and then with living and virulent cultures. This is the serum that was used in the recent outbreak of plague at Oporto. Dr. Calmette and Dr. Salimbeni have published the result of their investigation into the efficacy of this serum as ascertained by them in the treatment of patients at Oporto, and there can be no doubt, as the statistics stand, that the results are highly in favour of the value of the serum. This statement, however, requires qualification, owing to the fact that the comparison is not made between patients treated in hospital with serum and patients not treated with serum, but between patients treated in hospital with serum and patients treated at home without serum. The experiment is accordingly not under the same conditions, but the results are so dissimilar that it is impossible not to give the serum considerable credit for the contrast. It appears that out of 142 cases treated with the serum in hospital 21 of the patients died, which is equal to a mortality of 14.78 per cent., while out of 72 cases treated at home without serum 46 of the patients died, which is equal to a mortality of 63.72 per cent.—i.e., the mortality in hospital was five times less than the mortality at home. Success seems to have been more certain when the serum was used in large doses and when employed intravenously; thus the best results were obtained when, at the beginning of the illness or as soon as the patient came under observation, an intravenous injection of 20 cubic centimetres of the serum was given followed by two subcutaneous injections of 40 cubic centimetres each in the first 24 hours and by subcutaneous injection of from 10 to 20 cubic centimetres, or 40 cubic centimetres on the next and subsequent days until the temperature fell to normal, and even for two days afterwards. No ill results ensued from these injections further than an occasional erythema and articular pains which were no more intense after the intravenous than after the subcutaneous injections.

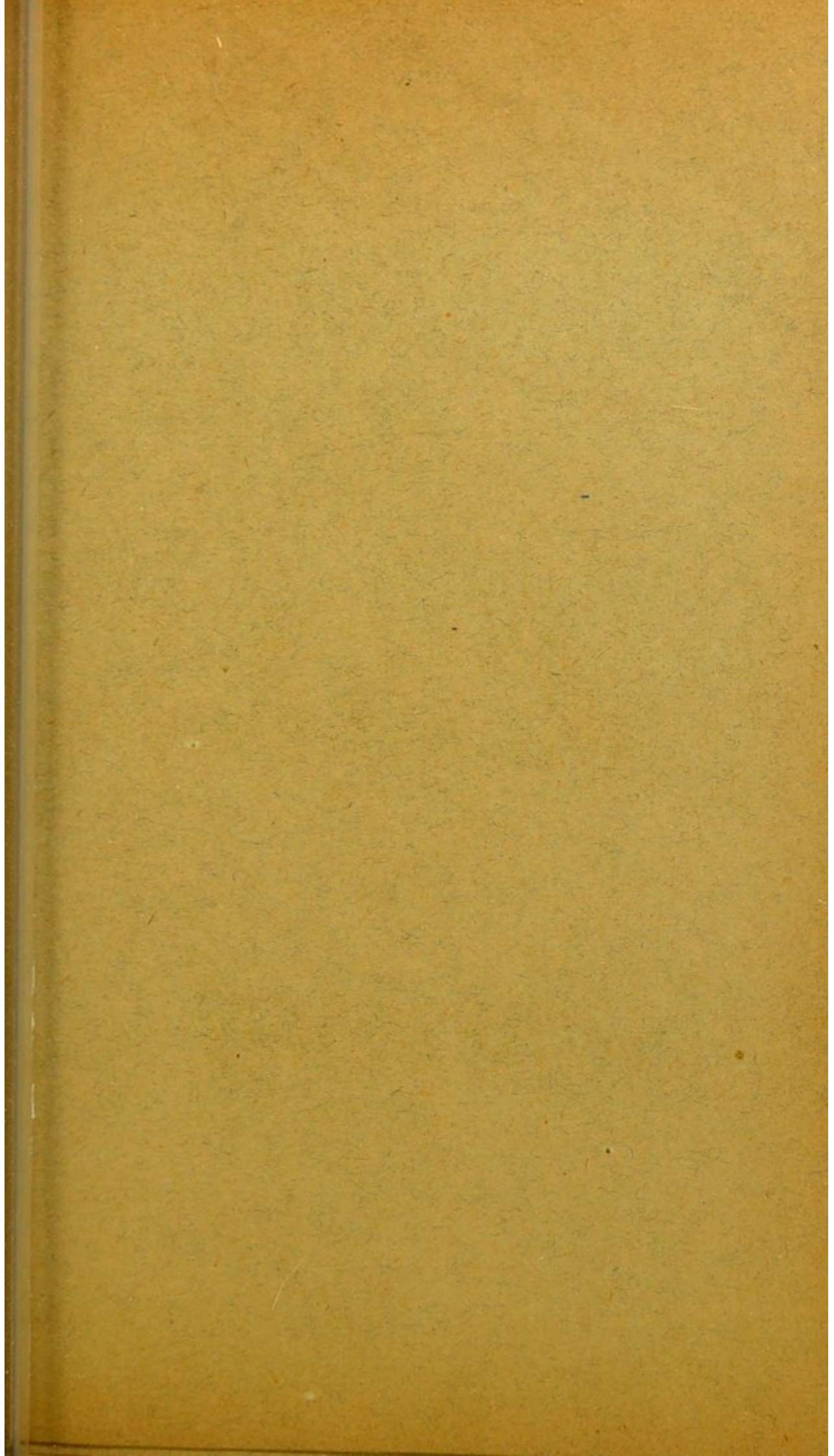
PREVENTIVE MEASURES.

Of preventive measures for the medical attendant, the nurse, and the relatives who may have close association with plague patients the most important is Haffkine's plague prophylactic. Of preventive measures for a country, in addition to those recommended by the Venice Convention

and the destruction of rats, the most important is that its medical men, especially its port health officers and medical officers of health, should be able to recognise plague when they see it, and for this purpose I would recommend that the same methods be adopted in England as in Germany—viz., that under the auspices of the Government there should be instituted a course of instruction on plague to be attended in batches by the medical officials of the country.

Gloucester-place, W.







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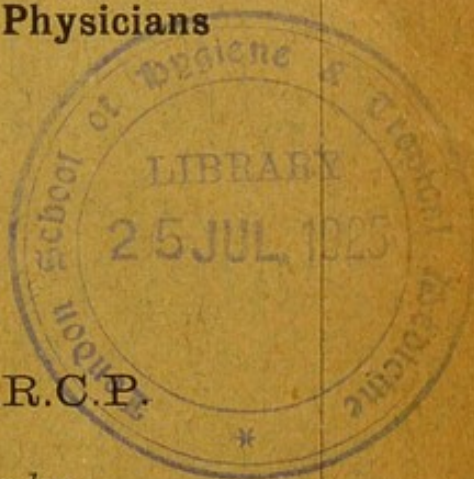
The Croonian Lectures on Plague

Delivered before the Royal College of Physicians
on June 18, 20, 25 and 27

BY

W. J. SIMPSON, M.D., F.R.C.P.

Professor of Hygiene, King's College, London



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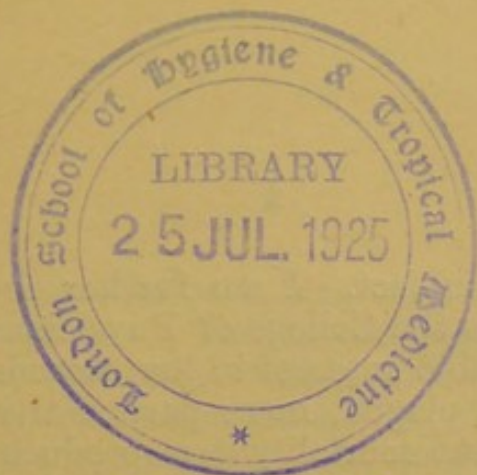
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LECTURE I.

Delivered on June 18, 1907.

INTRODUCTION.

MR. PRESIDENT AND FELLOWS,—I esteem it a great honour to have been asked to deliver the Croonian Lectures for this year, and it is with a deep sense of responsibility that I undertake the duties. My predecessors in this important office have placed before the College the results of their scientific researches in anatomy, physiology, and pathology, which have afterwards proved to be of the greatest practical value to the physician and surgeon in the domain of curative medicine. I am not in a position to follow in their footsteps, my province lying in another direction, and it would therefore be presumptuous on my part to attempt to throw light on my subject from that point of view. If I therefore depart from the usual course adopted in these lectures, with perhaps the exception of the late Sir John Burdon Sanderson, who in 1891 lectured on "The Progress of Discovery relating to Origin and Nature of Infectious Diseases," it is because my work has been mainly concerned with the application of scientific medicine in its preventive aspects.

The subject I have selected for these lectures is "Plague." It is one which a few years ago could only have been treated from a historical point of view; now it is of intense interest, for it has suddenly become the most important epidemic disease of the present day.

Plague has within ten and a half years caused in India over five million deaths, of which over four millions have occurred during the past five years. It is because of this mortality, and because it is generally supposed, erroneously, I think, that as far as Europe is concerned, plague is a disease of the past and will not prevail in epidemic form again, that I propose to

lecture on this subject. I am further encouraged in doing so because the College of Physicians has taken a very considerable interest in the recrudescence and development of plague, more particularly with reference to the great mortality it is producing in India, and has shown that interest by the deputation headed by the President which waited on the Secretary of State for India in July, 1905, representing to him the gravity of the situation in India.

DISCOVERY OF THE PLAGUE BACILLUS AND ITS RESULTS.

Plague is a very ancient disease, but the recent discovery of the causal agent is so epoch-making that it divides its history into two distinct periods of very unequal length. The first period is that previous to 1894, before the discovery of the bacillus of plague by Kitasato and Yersin. The second covers the years which have elapsed since that discovery. One extends over several thousands of years at least; the other is only some thirteen years old.

The fact that the specific bacillus is found in the buboes of the bubonic form, in the blood of the septicæmic variety, in the contents of the vesicles and pustules that sometimes appear on the skin and in the sputum of pneumonic cases, places the physician in a more favourable position for diagnosis of this disease than he ever was before. It provides him with a test, confirmatory or otherwise, of the suspicions he may have arrived at from the clinical symptoms of the disease, and enables him to come to a conclusion with a degree of certainty which was previously impossible. It should also put an end in future to the controversies and discussions similar to those which invariably arose in former times when an epidemic threatened, and which resulted in loss of valuable time before measures were taken to check the epidemic.

Smears from the contents of plague buboes, or from the hæmorrhagic effusion around them, and from the sputum of pneumonic cases, show usually on staining large numbers of bipolar microbes. In some cases, however, the microbes are few in number, and in rare cases their presence is not discoverable by the

microscope, but only by culture and inoculation into susceptible animals. This is practically the rule for the blood in septicæmic cases, and also in bubonic cases a short time before death.

The typical plague bacilli, with their bipolar staining and ovoid shape, are frequently mixed with others less typical, having a great variety of forms, including long and slender bacilli, and taking on the stain more faintly. Spherical-like and disc forms may be found in old buboes during life, and in affected tissues after death. These swollen and irregular-shaped bacteria do not stain well in their advanced stages, and ultimately present only a mere outline. The importance of these forms lies in the fact that they are prone to lead to mistakes unless the great variations which the plague microbes may undergo is borne in mind. Valuable as the morphological and staining characteristics of the plague bacilli are in times of plague, they cannot be wholly depended on to decide whether the first cases of an unknown or suspected disease in a hitherto healthy locality is plague. Resort has then to be had to cultures, which, in the case of plague, give particularly trustworthy results.

The stalactite growth in peptone broth which was discovered by Haffkine is the surest test in that no other bacilli give similar stalactite formations. A few drops of oil or butter fat may be added to the peptone broth. In either medium kept in a condition of perfect quietness the plague germs grow from the surface downwards into the fluid in the form of stalactites. To obtain the formation the flask has to be secured against the slightest vibration and against sudden changes of temperature, especially if applied to one side of the flask. In London, in the vicinity of the underground railway, such are the vibrations that the stalactite formation is very difficult to obtain. If nutritive gelatine is used instead of broth, and the culture is kept in the incubator at 35° C., the medium remains fluid, and the stalactite formation is more easily obtained, and is particularly typical.

The involution forms which the plague bacilli assume in dry agar are also very distinctive. They only appear in bacilli which have been recently re-

moved from the bodies of plague patients, and are generally lost when the microbe has been cultivated for some time in the laboratory. The involution forms when quite typical are spheres and cells of various sizes resembling yeast cells, and are many times larger than the bacilli themselves. They undergo various changes according to the age of the culture.

Normal at first, they become slightly swollen and rounded; later their size increases, and they may reach in volume as much as twenty times that of the original bacillus. These forms at first take the stain well, but subsequently portions of the cell stain more faintly. Later the whole cell refuses to stain, and ultimately there is seen only powder-like granules indicating the position of the cell. In other cases the involution takes another form, such as pear and crescent shapes and filaments of unequal diameter.

A third characteristic is the appearance of the culture on dry agar. When the plague bacillus is spread uniformly over the surface of dry agar from which all condensation fluid has been evaporated, the growth on culture is uniform and possesses a peculiar appearance. When the tube is held in a horizontal position, with the growth downwards, and is examined through the depth of the agar by reflected light, it has the appearance of the sheen seen in the back of a looking-glass. Unless dry agar is taken this appearance is not obtained, and instead of a shining uniform growth there will be a layer of microbes of varying thickness, and strewn over this growth will be colonies of different sizes, suggesting contamination by extraneous microbes.

Inoculation of the microbe into susceptible laboratory animals, such as rats, guinea-pigs, and mice, furnishes an additional test in these earlier cases.

The certainty of diagnosis which has thus been acquired by the physician is of inestimable value on the first appearance of suspicious cases in a community. Thus the Public Health Authorities in this and other countries are able to at once determine whether a suspicious illness or death reported to them is plague or not, and on the information obtained to take immediately, if necessary, the requisite measures to check the spread of the disease.

Certainty of diagnosis is not the only advantage derived from the discovery of the bacillus. Investigations into plague have been given a precision which was impossible before, and many observations can now be confirmed by experiments. For instance, it is now absolutely proved that the epizootic of rats which has been observed so frequently as associated with plague epidemics is plague in rats. It was suspected and acted upon formerly, but now the relationship is established. The isolation of the bacillus has also led to the discovery of Haffkine's prophylactic, the value of which as a preventative of plague is, as will be shown later, well established. Whether sufficient advantage has been taken of the new knowledge thus acquired will be considered afterwards.

It would be a mistake to suppose that because the present period has been so fruitful of results from a scientific and practical point of view that the past is sterile. On the contrary, it is full of observations of the highest importance, the value of which is only being slowly realised as greater experience in plague epidemics is gained. The clinical aspects of plague are as well described by the older authors as by the most recent, the mortality is as great to-day as formerly, the variation in the types of the disease was known, and the epizootic among rats and other animals, and the *rôle* which some of them play in the spread of the disease, were recognised and formed the bases of some of the preventive measures employed to check the disease.

It will accordingly not be wasting time to briefly refer in this first lecture to some of the more salient facts connected with the history of plague. The antiquity of the disease, its endemic centres, its pandemics and epidemics, which are all so well described by Dr. J. F. Payne, a distinguished Fellow of this College, need not detain us.

THE PANDEMICS OF THE SIXTH AND FOURTEENTH CENTURIES.

Pandemics of great magnitude are fortunately few in number and far between. There have been several pandemics, but two only are recorded as standing out

conspicuously as scourges of a particularly devastating character, and the effects of which were felt for many years after they had disappeared. These were the Justinian pandemic in the sixth century and the Great Pestilence of the fourteenth century, later called the Black Death. The long interval of eight hundred years intervened between these two great pandemics of plague. Between them were many epidemics of plague in Europe, Asia, and Africa, some of which assumed more or less pandemic proportions, but none reached the dimensions of these two.

The origin of neither is known, but in both great commercial centres played a prominent part in maintaining and distributing the infection. The Justinian plague, which continued over fifty years, first attracted attention by its outburst at Pelusium, which was then an emporium for the produce of the East and the West. The endemic centres of Mesopotamia, Arabia, and Æthiopia were in commercial relationship with Pelusium, and it is probable that the infection came from one of these. The balance of evidence is in favour of Æthiopia. It is a matter of interest to note that within recent years endemic centres of plague have been discovered in German East Africa and Uganda. The town in which plague reaches such dimensions as to attract more than local attention is seldom the one in which it originates. For instance, at the present day the pandemic now prevailing is commonly attributed to Hong Kong and Canton, whereas the disease was brought to these cities from the Chinese endemic centre of Yunnan.

The great pandemic of the fourteenth century was also associated with large commercial centres, for it entered Europe by the important emporiums and marts situated at that period on the Volga and in the Crimea, and which, as pointed out by Creighton, were the terminal marts of the northern caravans from China and the Far East. It should be mentioned, however, that they were also the marts connected with the trade routes from India.

The origin of the pandemic has been ascribed to China and India. The Russian records place its starting point in India. Clemow, in his recent work entitled

“The Geography of Disease,” points out that plague prevailed in India in 1332, and that probably the Russian chroniclers are correct. Wherever the pandemic arose there appears to have been for several years a wide diffusion of the disease in the large dominions belonging to the Tartars and the Turks, who at that time ruled over the greater part of Asia.

Galfridi le Baker Swynebroke set down the period of prevalence in Asia before plague entered Europe as seven years. When it did arrive it is estimated to have destroyed 25,000,000 of its inhabitants. England and Wales at the lowest computation lost 2,500,000 of its inhabitants, or about half of its total population.

For over three hundred years after this visitation Europe suffered from fresh invasions of plague, which reinforced the languishing infections already existing from previous ones.

In the countries attacked there were some epidemics in towns, which, though continuing only for a few months, are memorable for their great mortality. For instance, the epidemic in Venice in 1576 caused 70,000 deaths, that in Moscow in the same year, 200,000 deaths, that in Naples in 1656, 300,000 deaths, that in Rome in the same year, 145,000 deaths, that in Genoa 60,000 deaths, and the epidemic in London in 1665, nearly 70,000 deaths. It was exceptional for an epidemic to occur year after year, which in India is almost the rule, so that in the latter case the mortality accumulates to a proportion rarely recorded in former times, thus, for instance, in Poona, which is a town of some 120,000 inhabitants, over 40,000 of its inhabitants have died from plague in ten years, which is proportionately at least twice the mortality of the great plague of London in 1665. In Bombay over 150,000 of its inhabitants have been destroyed by plague. In this respect the history of plague tends to repeat itself. In the pandemic of the sixth century it is recorded that “if it passed over any place, only slightly or mildly touching the inhabitants, it returned there afterwards, leaving untouched the neighbours against whom it had spent its rage before, and it did not depart from there until it had made up the full measure of the dead in proportion to the

amount of destruction which it had brought on its neighbours."

THE EFFECT ON THE LIVING OF GREAT EPIDEMICS
OF PLAGUE.

Great epidemics of plague not only destroy large numbers of people, but they leave their traces on the living. The effects on the living have usually been very marked and very similar. They are mostly psychological and social in their nature. Great numbers of the living are unable to bear the strain of the scenes around them and the uncertainties of life which the epidemic brings too plainly before them. Minds which have hitherto been sober and calm become unhinged and hysterical. Excitability and suspicion are engendered, often leading to illusions, delusions, and excesses of all kinds, which in some instances become contagious and dangerous. The change is not sudden, but comes gradually. First of all the normal courage, solicitude for the sick, hope, and religious trust, which belong to the healthy mind are unaffected, but later these are associated with intense pity, exaggerated religious fervour, and the deepest despair; then they are followed by panic and a total revulsion of feeling, in which the predominant features are fear, selfishness, callousness, and heartlessness; and later still, if the scourge continues, there is a display of all the most sordid and worst passions on the part of the unbalanced portion of the population.

Plague, above all disasters, tends to bring out for a time the weak points in humanity, and seldom the virtues. Hecker gives an account of the frenzy and mania caused by the mental strain brought on by the terrible events associated with the Black Death. He describes the doings of the flagellants in Germany, Hungary, Poland, Bohemia, Silesia, and Flanders, who marched through the cities in well-organised processions, and who bore triple scourges, tied in three or four knots, in which points of iron were fixed, and with which they flogged themselves. Harmless and welcome at first, they later became a terror to the inhabitants of every place they visited. He describes also the epidemic of dancing mania that followed, and

he gives an account of the cruel and fanatical persecution and wholesale massacre of the Jews, who were accused of poisoning the wells and thus causing the plague. He says: "Already in the autumn of 1348 a dreadful panic caused by this supposed empoisonment seized all nations; in Germany especially the springs and wells were built over that nobody might drink of them or employ their contents for culinary purposes, and for a long time the inhabitants of numerous towns and villages used only river and rain water. . . . By this trying state of privation, distrust and suspicion, the hatred against the supposed poisoners became greatly increased and often broke out in popular commotions which only served still further to infuriate the wildest passions."

The suspicion and rumours regarding the poisoning of the wells in the Punjaub are only the reappearance of a part of the credulity and delusions which prevailed during the time of the great pestilence of the fourteenth century. There were other effects besides these disorders of the mind. The whole social structure became seriously disorganised owing to vast tracts of country becoming waste land, and an immense number of huts and houses becoming tenantless. Prices of commodities rose, rents fell, payment of the taxes on land could not be obtained. There were agrarian labour and political troubles. Labourers and workmen were scarce and demanded higher wages, and it was found impossible by laws, imprisonment, fines, or any other methods, to bring them to conform to the older order of things. A new era with a new spirit sprang into existence, which in the course of years and after many struggles banished the old.

THE PERIODIC QUIESCENCE AND RECRUDESCENCE OF PLAGUE.

The epidemics of the East and West have generally been more or less synchronous with one another. The last pandemic of plague was in full activity in the seventeenth century, and covered a large portion of Asia, Africa, and Europe, but towards the end of the century the disease began to contract its limits, leaving Western Europe free in the course of a few years, a

freedom which, with one notable exception, has continued.

That exception was the epidemic in 1720 in Marseilles, when sixty thousand of its inhabitants died of plague, which had been imported from the East. As regards the rest of Europe, the retrocession continued, and in the course of one hundred and fifty years plague not only disappeared from Europe altogether, but also showed a remarkable cessation in its old endemic centres of Mesopotamia and Arabia. What remained of the disease was shown by Tholozan to pass through a very definite stage of development, being mild at first, then virulent, and again mild, and the preponderating element was mildness. The mild plague consisted of glandular swellings unaccompanied by fever, the swellings showing themselves in the groin, armpit, or neck. The epidemics which Tholozan studied were observed by him to be self-limiting in their extension, and as he points out, were not controlled by the plague measures which were often adopted after the plague outbreak had ceased. Within recent years the plague epidemics that arose from the old centres in Mesopotamia and Arabia were apparently incapable of wide extension, and even under conditions seemingly most favourable for their spread.

The conclusion from Tholozan's researches appeared to be that for epidemic plague endowed with qualities of diffusion, whatever that may mean, no quarantine on land would stop its progress, while for other epidemics of a self-limiting character quarantine on land was not required.

Following the retrocession and contraction of plague, Europe has remained free for over sixty years, broken only by a short but virulent outbreak on the Volga in 1879, investigated by Dr. F. J. Payne and Surgeon-Major H. Colville, by a small outbreak at Oporto in 1899, and a few cases at Glasgow and Naples in 1900.

Western Europe has been free for nearly two hundred years, the last epidemic being at Marseilles nearly one hundred and eighty-seven years ago. The Great Plague of London occurred more than two hundred and forty years ago.

Quiescence of plague for varying periods is not a new feature in the history of the disease. It is necessary to emphasise this fact, for the long quiescence in Western Europe has given rise to the view that Europe has seen the last of its plague epidemics, and accordingly the epidemic now prevailing in India is viewed with regrettable complacency. I think this view of the invulnerability of Europe is as likely to be as correct as the prevalent notion that London was freed of plague by the great fire, irrespective of the fact that plague remained in London for fourteen years after, and that the disease disappeared from the whole of England and most of Western Europe about the same time.

Subsequent to the Justinian plague and its offshoots, Europe, with the exception of an epidemic in Constantinople in 697, and another in Sicily, Calabria, and Constantinople in 749, remained free of plague for four hundred years, and Syria, which is nearer the endemic centre of Mesopotamia, remained free for two hundred years. Bagdad, itself in the centre of the endemic area, remained free for some fifty years at the commencement of the Abbasidic dynasty, at a period of unexampled prosperity. Moreover, Egypt, which has suffered at varying intervals from devastating epidemics of plague during the past two thousand years, remained free of the disease from the eighth to the eleventh century, or a period of three hundred years. Long immunity of towns as of countries is also not uncommon in regard to plague epidemics, even when plague is in the country. When Bombay was attacked with plague in 1896, it had been free of the disease for one hundred and eighty-four years; when Moscow was attacked in 1771 it had been free for one hundred and fifty years, and when London was attacked in 1499 it had been free for one hundred and fifty years.

Various explanations have been given of the retrocession of plague from Europe. It has been ascribed to the social and sanitary improvement of the people since the seventeenth century; it has recently been set down to the invasion of the *Mus decumanus* at the beginning of the seventeenth century, and the re-

tirement, except from the seaports, of the *Mus rattus*, and it has been attributed to the abandonment of overland routes as the principal means of transport and communication between the East and West, to the substitution of sea-routes, and to the introduction of quarantine at seaports trading with infected countries. None of these explain in a satisfactory manner the sudden retrocession of plague, which stands as a remarkable epidemiological fact, but individually and collectively they may have exercised an important influence in keeping the disease in check once it had receded. Probably the most powerful of these was the change of land routes to sea routes, whereby the transport of goods from the East to Western Europe was no longer effected by caravans which passed through the endemic centres of plague in Mesopotamia and Arabia. It was a change which must have materially lessened the chances of infection and of importation of the disease.

From this point of view the new railway schemes which are to link the East with the West, and re-open the old overland trade routes, are not unlikely, unless special precautions are taken, to once more bring with them the risks of plague importation.

THE GENERAL CLINICAL FEATURES OF PLAGUE.

Clinically, plague presents the same features to-day as those described by the most ancient writers on the subject. The accounts of the disease are remarkably alike, whether given by Dioscorides and Posidonius in the third century before the Christian era, and referred to by Rufus a century later when writing of the plague prevailing in Lybia, Egypt, and Syria, or by Procopius in the sixth century, or by Guy de Chauliac in the fourteenth century, or by Skeyne in the sixteenth century, or by Diemerbroeck, Lodge, Hodges, or Bognhurst in the seventeenth century, or by the numerous writers on plague since that time up to the most recent years.

The glandular swellings in the bubonic form, the coughing of blood in the pneumonic, the extreme prostration, pallor, muscular weakness, delirium, and rapid death in the septicæmic, and the appearance of boils

or blains in the carbuncular type, have been observed and described in both ancient and modern epidemics of plague.

Procopius graphically describes the sudden onset and fever, the appearance on the day of attack, or the next day or a few days later, of the bubo in the groin and armpit and sometimes in the neck, the drowsiness in some, the madness in others, the desire to wander, and the difficulty of keeping some patients in bed. He mentions the large size and suppuration of the bubo as indicating a milder attack, and the reverse a severe and fatal illness; and he draws attention to a feature which every physician soon learns for himself, viz., the uncertainty of prognosis. The patient's appearance is most deceptive, and cannot be taken as a guide; patients pronounced to be getting well will not infrequently suddenly die, and others in whom all hopes of recovery are abandoned recover with a rapidity that is marvellous. Procopius does not forget to record the comparative immunity of physicians and attendants.

The description by Guy de Chauliac of the epidemic of Avignon in 1348 is of special interest, because it is written by a medical man of high standing in his day, and because it distinguishes more clearly than others before him the pneumonic and bubonic forms of plague. Guy de Chauliac was himself attacked with plague towards the end of the epidemic, but recovered. He says: "I felt a continued fever, with a swelling in the groin, and was ill more than six weeks in such great danger that all my friends thought I should die, but the swelling ripening under the treatment I have described, I escaped by the mercy of God." The treatment consisted in the application of figs and cooked onions mixed with plantains and butter, to ripen the swellings, followed by incisions and the usual treatment of open sores. Describing the epidemic, he says: "The plague commenced in January, it continued seven months, during which time it appeared in two forms. During the first two months it was accompanied by a continuous fever and with a coughing of blood. All who were attacked died in three days. During the other months the continuous fever was

accompanied with tumours and boils, which appeared on the external part of the body, chiefly in the armpits and the groin. Those who were thus attacked died in five days. The disease was so severe and so contagious, especially that which was attended by coughing of blood, that it was contracted not only by visiting and living together with the sick, but by being in their presence, so that people died without service and attendants. Men were buried without priests and without religious rites, the father abandoned the son, and the son approached not the father. Charity was dead and every hope lost."

The very infectious character of pneumonic plague as distinguished from the other forms of the disease is now fully established, and it is the one form which is dangerous to medical men, nurses, and attendants on the sick. The sputum and blood coughed up teems with plague bacilli, as was first shown by Major Child, of the Indian Medical Service. Fortunately, most epidemics of plague partake more of the bubonic than the pneumonic variety, otherwise the liability to infection would be as great as it is in influenza.

VARIATION IN TYPE AND BEHAVIOUR OF DIFFERENT EPIDEMICS.

All epidemics are not alike, although their general characters are similar. The bubonic, pneumonic, septicæmic, and carbuncular varieties of the disease may vary much in their relative proportions in different epidemics, and symptoms may be present in some epidemics which are absent in others.

The situation and relative position of the buboes may differ, and instead of being with the usual frequency in the groin, armpit, and neck, may be found in the popliteal space, elbow, and other positions. In older epidemics carbuncles and tokens or petechiæ were observed, but they have been rare in later epidemics. In the epidemic of the sixth century affections of the throat and withering of the limbs and gangrene were added to the buboes, carbuncles, and black boils or pustules; in the fourteenth century the pneumonic form was particularly prevalent; in the sixteenth and seventeenth centuries sweats were a

distinct feature. In the plague of London there were coloured sweats. Hodges says: "These sweats also of the infected are not only profuse, but also variously coloured; in some of a citron hue, in others purple, in some green or black, and in others like blood. The sweat of some would be so fœtid and intolerable from a kind of empyreumatic disposition possibly of the juices, that no one could endure his nose with the stench." Nothing of this kind has been recorded in recent epidemics, nor have the carbuncles which formed a very conspicuous and common feature in many epidemics been observed of late years with much frequency; when they have been observed the type of plague has generally been of a milder character. This mildness was also noticed in a number of the Egyptian epidemics, contrasting much with other epidemics in which the carbuncles always signified a very fatal form of the disease. The comparative absence of nervous symptoms and septicæmic cases gave to the Cape Town epidemic a character differing in these respects from that of the Hong Kong and Bombay epidemic which I saw. The Poona epidemic of 1906 also struck me as presenting fewer of the nervous disturbances which I witnessed in the epidemic of 1897. It is noticeable that when the disease is comparatively mild, views as to its non-contagiousness prevail, whereas when severity is its distinguishing feature contagion is in favour. Recent observations would indicate that both contagionists and non-contagionists were right to some extent, though their views were of the most opposite character. Pneumonic plague is directly infectious from man to man, the bubonic is not directly infectious, while the septicæmic may possibly be both directly and indirectly infectious. It would accordingly depend on the proportion of each of these varieties in an epidemic as to the contagiousness or the non-contagiousness of the disease being most predominant.

The great proportion of pneumonic cases in the epidemic of 1348, and the contagiousness of this form of the disease, probably accounts for the rapidity which characterised its spread, and which has recently been observed to be a marked feature in small local out-

breaks of this form of the disease. If this pandemic be excepted, together with a number of small local outbreaks of plague, a peculiarity of plague is its slow progress from place to place; districts and towns close to those infected remaining for a long time free of the disease.

A frequently quoted instance is the great plague of London taking six months to travel from St. Giles' to Stepney. In Bombay the plague confined itself to the dock quarters before it spread to other districts. At Poona over six months elapsed before the disease established itself at Kirkee, which was in daily communication with Poona, and only separated by a river spanned by a bridge. During the first outbreak in Canton in 1894, in which 80,000 out of 1,000,000 inhabitants died of plague, the disease never crossed the narrow creek, some 20 yards wide, which separated plague-infected houses in the Chinese town from the European settlement of Shamien: neither Europeans nor the Chinese servants on the premises, nor the rats in the foreign settlement, were affected. The water here provided a check to the spread of the disease. It was also observed that the Chinese population living on the river did not suffer from the epidemic, which reminds one of a similar observation during the great plague of London. It is facts such as these and that animals living in the ground were affected by plague, that gave rise to the view held by the Chinese and the older non-contagionists in Europe that plague was a soil disease, and that the spread of it was due to miasmata from the ground. The discoveries of Manson and Ross have revolutionised our notions of miasmata; and from this new standpoint the miasmata of plague appear to be explained by the rôle which the rat and the flea play in the dissemination of the disease; but many links are wanting before a satisfactory explanation of the recrudescence of plague is available.

ANCIENT ASSOCIATION OF THE RAT WITH PLAGUE EPIDEMICS.

The association between plague and rats is a very old observation. Apart from scriptural references

there is evidence derived from some of the ancient monuments and coins of the connection being known. Apollo and Æsculapius are each represented with the rat at their feet. There was the famous statue of Apollo, by Skopias, in which the god has a rat at his feet.

Snakes are destroyers of rats, and in Asia Minor and elsewhere, before the advent of the cat, harmless snakes were kept in houses and in the temples, doubtless for that purpose. This practice probably explains the accounts so frequently given of snakes and serpents dying during epidemics of plague. Both the cat and snake were venerated for their services to man.

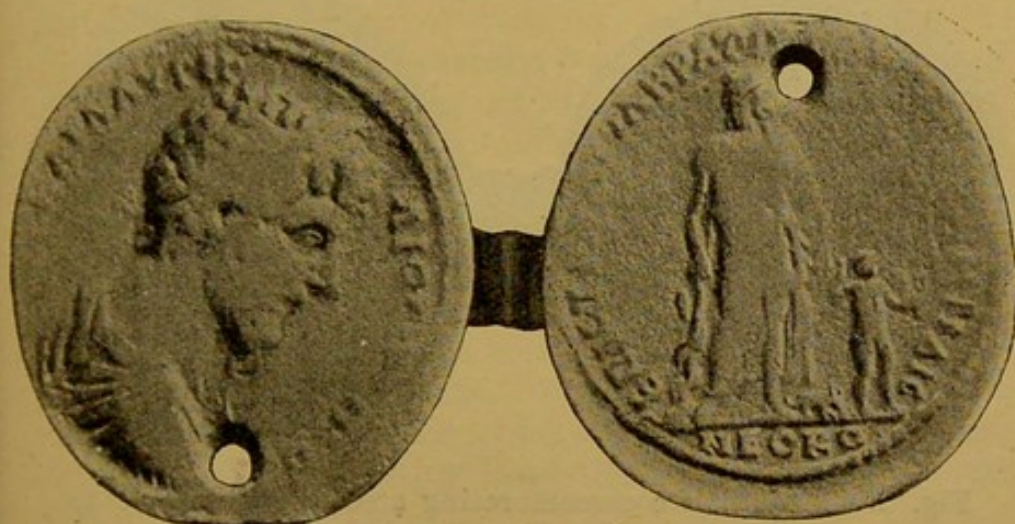


Fig. 1.—Coin of Emperor Lucius Verus commemorating plague epidemic.

There is an interesting coin brought to my notice by Dr. Sambon, and which can be seen in the collection of colonial Roman coins in the British Museum. It is a coin of the Emperor Lucius Verus struck at Pergamum, in Asia Minor, during a plague epidemic, and represents Æsculapius with a rat at his feet and a small human figure standing by with his arms outstretched in the attitude of fear or worship (fig. 1).

In the same collection there is a medallion of the Emperor Antoninus, struck in commemoration of the erection of a temple to Æsculapius on the Tiberine island at Rome. Plague was epidemic in Rome, and

a mission was sent to the temple of Æsculapius, at Epidaurus, to ask for advice. The advice given by the Æsculapian priests was apparently to destroy the rats, for on the obverse side of the coin is the return of the mission with a serpent being welcomed by the river god (fig. 2).

The dissemination of plague by domestic animals was formerly recognised even more than it is at the present day, and very decided views were held, particularly regarding those animals in close association with man. Not only rats, but also dogs, fowls, and pigs were held to be agents in spreading the disease. When plague prevailed in Europe, these animals were



Fig. 2.—Medallion commemorating erection of temple to Æsculapius by Emperor Antoninus.

as much inmates of the house as the people themselves, and it was observed, as it is in South-western China to-day, where the same conditions prevail, that during epidemics of plague the rats, fowls, pigs, and cattle sickened or died, which was attributed to plague. In the pandemic of 1348, it is recorded by numerous observers that dogs, cats, fowls, cattle and rats died of the disease. Skeyne, in 1568, in his work on the pest, states that "quhan the domestical foules become pestilential, it is ane sign of maist dangerous pest to follow." The observations became so general that they formed a basis for certain orders in regard to the suppression of plague. Every European country has in its old orders concerning the checking of plague

epidemics, instructions to the inhabitants under certain penalties to kill domestic animals or to keep them confined to the house. Creighton mentions some of these orders, as bearing on the regulations in England and Scotland against the spread of plague.

In the regulations in London against the plague in the seventeenth century, it is ordered that no hogs, dogs, pigeons, or conies shall be suffered to be kept within any part of the city.

In Rouen, on April 14th, 1407, it was ordered under penalty that no person of any condition or rank should keep pigs. When plague broke out again in 1498, a similar order was issued, and in 1566 the priests of the Madeleine and Commander of St. Antoine were forbidden to keep in their houses pigs, fowls, and rabbits.

At Evereux, in Normandy, a police order was issued in 1561, that everyone of whatever quality or rank should not keep pigeons, fowls, rabbits, and pigs under penalty of confiscation and a fine of 10 livres, and any one giving information would receive half the fine. The killing of dogs is in nearly every order. A photograph lent to me by Mr. Henry Wellcome, who is collecting for an exhibition which he proposes to hold on the "History of Medicine," of a painting in the archives of Bologna representing a plague epidemic in that town, is interesting, as it illustrates the actual killing of dogs during the epidemic.

The picture shows the magistrate and his officers on duty. Some of them are removing the dead which are being lowered from the windows of the infected houses, priests are also to be seen administering the sacrament. In the foreground are some men killing a dog, and a little further back there is a dog transfixed with an arrow. Similar measures for controlling plague were taken at Palermo in 1575. Ingrassias says "an excellent measure was proposed and carried out. All dogs, cats and other animals that might convey the plague from one house to another were to be destroyed." Not only were the dogs of the town destroyed, but all those within a radius of at least four miles.

Fiochetto, describing the measures that should be taken in the event of the discovery of an infected

person in any house, says, "fifthly, having killed all cats, dogs, fowls, and pigeons, prepare arsenic for the rats."

No mention is made of fleas on these animals, but it is evident that experience had taught the authorities that these animals sometimes by contracting the disease and sometimes by carrying the infection on their coats, furs and feathers, though not infected themselves, conveyed plague. In connection with the conveyance of the infection by animals not suffering from the disease, there is the observation made by the Austrian Commission in 1897 of plague bacilli appearing in the fæces of a dog fed with plague material.

LECTURE II.

Delivered on June 20, 1907.

THE PRESENT PANDEMIC.

MR. PRESIDENT AND FELLOWS,—The present pandemic has no connection with the plagues arising in Mesopotamia, the chief features of which, as shown by Tholozan, were, during the latter part of the nineteenth century, those of comparative mildness, spontaneous cessation, and self limitation, irrespectively of preventive measures. It would appear that the strain of the Mesopotamian virus has become attenuated both in powers of attack and powers of diffusion, and that it required a virus derived from a new source or from another endemic centre to produce a plague endowed with more virulent and diffusive qualities.

The Chinese endemic centre in Yunnan, from which the present pandemic is derived, is like the endemic centres in Arabia and India, between 5,000 and 7,000 feet high, and in this respect differs from some of the older endemic centres which are low lying. Yunnan has been known as an endemic centre of plague since 1870, but there are Chinese records which seem to indicate that the disease probably existed there for over one hundred years, for mention is made of a strange and fatal rat disease prevailing at the end of the eighteenth century which also infected the inhabitants. There are no records discovered which make the endemic centre older than this and there is no evidence to show that the Black Death of 1348 arose from Yunnan. It is not known exactly when the present pandemic overflowed its boundaries and invaded the adjoining provinces of Kwangtung and Kwangsi. Plague had passed over the boundary several times during the Mahomedan rebellion in Yunnan, and in 1867 reached Pahhoi, a small seaport

on the southern coast of China, but there appears to have been no very extensive epidemic. As far as can be ascertained it was about the year 1890 that the disease began to show unusual activity. At that time the annual recrudescences in Mentze, one of the principal trading towns in the south-east portion of the province, became more severe and there was an extension of the disease to some of the towns situated on the West or Canton River and which have trade relations with Mentze and Canton. Gradually an extended area of the western parts of Kwangsi and Kwangtung became affected, and in January, 1894, Canton was attacked. Canton is the chief port as well as the largest and most important city in Southern China. It is only eighty miles from Hong Kong, which, situated at the mouth of the Pearl River, contains a population that is mainly Cantonese, and so great is the intercourse between them that Hong Kong has been styled the suburb of Canton. Hong Kong became infected in May, 1894. Recrudescences of plague have occurred more or less in Canton and Hong Kong since. Canton and Hong Kong are the great marts and distributing centres for the produce of Southern China and have trade connections with the southern parts of China, the neighbouring islands of the Pacific, and with India, Australia, Japan and America. They were accordingly favourably situated as distributors of plague to all those countries adjacent and distant with which they had commercial relations. Their ships carried infection to the seaports of other countries, and these in their turn infected other places. The course of the spread of plague has differed from all previous pandemics in that its distribution has been by sea routes, in contradistinction to former pandemics which spread by land routes and coasting vessels. With the exception of India and one or two places in South Africa and America the infected localities are mostly on the coast, and the history of their infection is importation of the disease from some infected port with which they carry on commercial relations. Any circumstance which increases to an unusual extent the transport of goods from infected ports increases the risk of importation of the disease.

Thus the war in South Africa, with its enormous shipments of grain and fodder from the Argentine and from India, whose ports were infected with plague, introduced the disease into Cape Town and Port Elizabeth, where the rats in the docks were the first to become infected. The Russo-Japanese war was, fortunately for Europe, out of the zone of any badly plague-infected district.

Many places have been infected in different parts of the world, but none outside India have hitherto given rise to any very serious epidemic. Still, notwithstanding its apparent inability to develop into an epidemic, yet the disease has in many instances, when imported into a locality, shown a remarkable persistence as displayed by the annual recurrence of sporadic cases at the season of the year favourable to epidemic plague. The potentiality of plague becoming epidemic in such localities is there all the same, and no country is safe while it retains infection.

THE EPIDEMIC IN INDIA.

At present, however, the chief interest of this pandemic lies in India. Imported into the city of Bombay in 1896 from Hong Kong, it broke out in epidemic form in September of that year, and by the end of April, 1897, when the first epidemic was over, it had caused 11,000 deaths. Every year there has been a recrudescence, and the total number of deaths from plague in Bombay since its appearance till the end of 1906 is 150,000. From Bombay city it spread to the Bombay Presidency, chiefly by coasting boats and by the railways carrying fugitives infected with plague to their native villages. By December, 1897, 50,000 deaths had occurred in the Presidency, and a few deaths in some of the other provinces. It has continued ever since in this Presidency, and has, up to the end of April, 1907, caused 1,500,000 deaths. Gradually the disease has spread to the other provinces of India, affecting some severely and some lightly, and the grand total of deaths from plague in India, as shown in the following statement of annual deaths, amounts to over 5,000,000 :—

TOTAL RECORDED ANNUAL DEATHS FROM PLAGUE IN INDIA.

Years	British Territory	Native States	Total
September, 1896, to end of 1897	57,000	—	57,000
1898	89,200	27,000	116,220
1899	102,300	36,000	138,900
1900	73,500	19,200	92,700
1901	234,600	46,100	280,700
1902	445,200	126,900	572,100
1903	701,800	179,000	880,800
1904	938,000	203,300	1,141,300
1905	940,800	128,300	1,069,100
1906	—	—	332,000
1907 (first four months)	—	—	641,000
			5,321,800

The population of the British territory is 232,000,000, and that of the native States 62,000,000. The 5,000,000 deaths represent accordingly one death in every sixty of the inhabitants of India. The mortality during the later years is very much greater than in the earlier, the deaths in the last five years and four months reaching over 4,500,000.

The fact that India is an immense country with nearly 300,000,000 inhabitants has often been considered as minimising the gravity of the situation which 5,000,000 of deaths would otherwise represent, and the argument is employed that in such a large country it is impossible to deal with the disease. One million deaths a year in a population of 300,000,000 is viewed only as one death in 300 of the inhabitants, and from that point appears not to have much influence on the vast population. It is once more the fallacy of averages. There is the old story of the man who, assured that the average depth of a river was 4 feet, endeavoured to cross it and was drowned. He had not reckoned that it might be shallow in some parts and deep in others. Plague is not epidemic over the whole of India. But even if it were, and admitting that India, including Burma, is greater by 12,000 square miles than the whole of Europe, excluding

Russia, Poland, and Finland, most people will allow the mortality is serious. Five million deaths from plague in Europe would be considered on this side of the Red Sea appalling in whatever way it was distributed. And if it happened that many of the countries in Europe were more or less free from plague, and that the disease concentrated itself on three or four countries, such as France, Italy, Austria, and Great Britain and Ireland, causing in these nearly 4,500,000 deaths out of the 5,000,000, the mortality would be viewed as a catastrophe of the first magnitude. But if in addition to the loss of the 4,500,000 of inhabitants there were, owing to the recurrence of the disease, a prospect of several more millions being destroyed in those places already attacked, and that there was the further danger as the pandemic developed of the other countries—such as Germany, Holland, Spain, Greece, and Turkey—being attacked in the same way, then the situation of Europe would be similar to that of India to-day. This will serve to give some conception of the tragedy which is going on in India at the present time, and of the future perils of that unhappy country. It is a misconception, fraught with the greatest danger, to suppose that in India the plague is only causing a death-rate of 3 per 1,000, as was stated in the House of Commons during the debate on the Indian Budget. The figures giving the total number of deaths in the different provinces of India since September, 1896, exhibit a very different degree of incidence and severity in each, as is seen in diagram A. The Madras Presidency has escaped with a comparatively small number of deaths ; so have most of the other provinces. Four provinces have hitherto borne the brunt of the epidemic in India out of the fifteen presidencies, provinces, and States into which India is divided. These are the Bengal Presidency, with a little over 500,000 deaths ; the Bombay Presidency, with a little over 1,500,000 deaths ; the United Provinces, with nearly 1,000,000 deaths ; and the Punjab, with over 1,750,000 deaths.

The annual returns for these provinces are approximately represented in the following figures :—

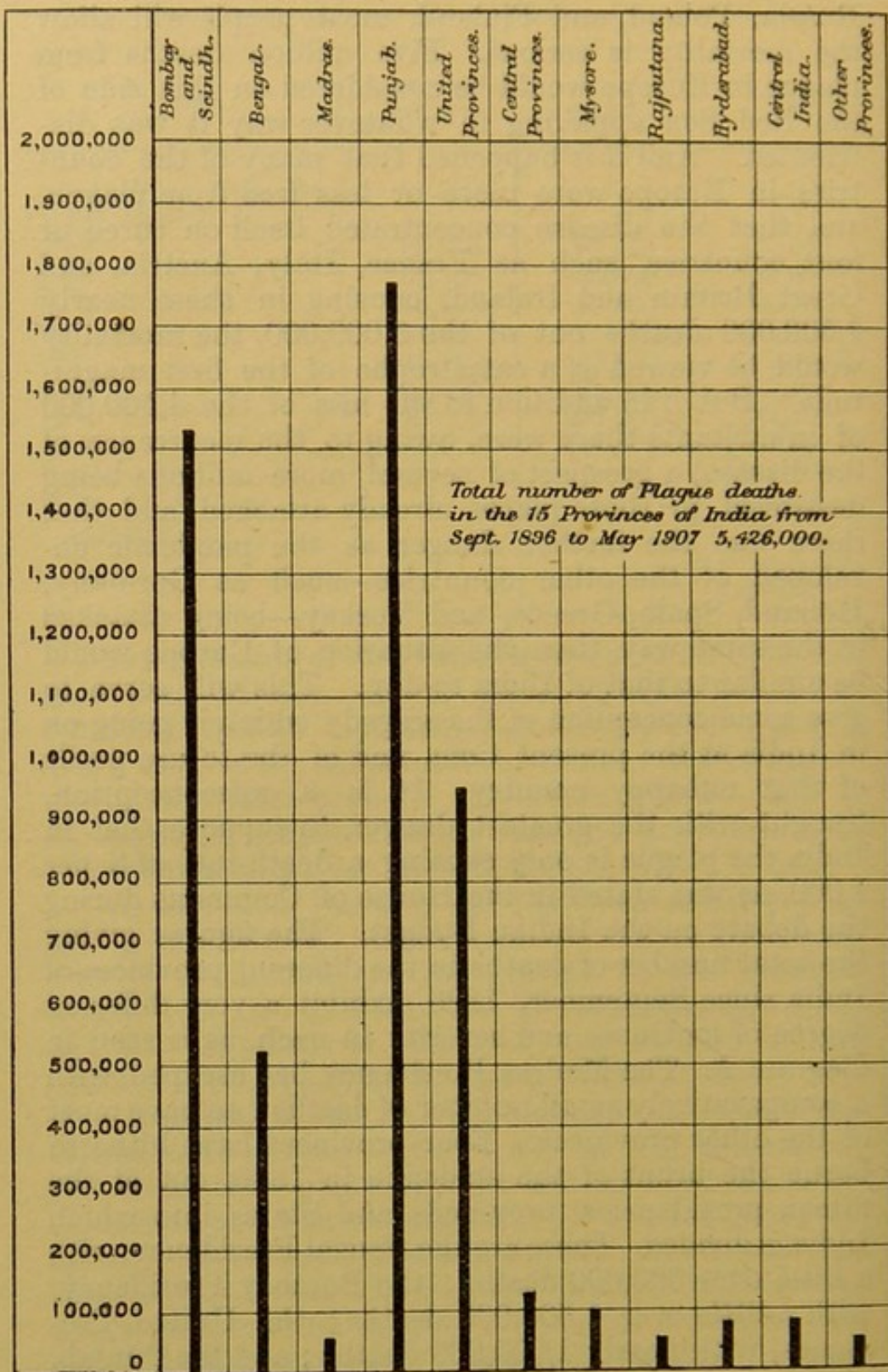


DIAGRAM A.

Year	Bombay and Sindh, population 22,000,000	Bengal, population 74,000,000	United Provinces, population 47,000,000	Punjab, population 25,000,000
September, 1895, to end of 1897	57,000	—	80	179
1898	104,000	166	116	1,800
1899	117,000	3,000	6	250
1900	38,000	37,000	116	500
1901	158,000	78,000	9,000	18,000
1902	217,000	32,000	43,000	222,000
1903	340,500	65,000	80,000	210,000
1904	281,000	75,000	179,000	402,000
1905	96,000	126,000	383,000	389,000
1906	71,000	50,000	57,000	98,000
To May 11th, 1907 ..	52,000	50,000	223,000	432,000

THE EPIDEMIC IN THE PUNJAB.

The province of the Punjab, which has lost nearly 1,750,000 of its inhabitants, is in size less than one-twelfth the total area of India, and it contains less than one-eleventh part of its population. It is slightly larger in area than Great Britain, but is smaller than Great Britain and Ireland. Its population, including the Native States, is 25,000,000, without the Native States 20,000,000, against the 43,000,000 of Great Britain and Ireland, so it is not a large province, and the loss of 1,750,000 out of 25,000,000 can only be viewed as an appalling disaster. If plague had destroyed 3,000,000 of the inhabitants of Great Britain and Ireland in ten years, it would have represented proportionately what the Punjab has lost during that time with its smaller population. The plague began very slowly in the Punjab, and took six years before causing 250,000 deaths. There were 179 deaths in 1897, 1,871 in 1898, 253 in 1899, 525 in 1900, then, as reported by the Sanitary Commissioner for the Province, all restrictions were removed, and a new policy was introduced; in 1901 there were 18,877 deaths, and in 1902, 222,533 deaths. The great mortality has been during the past four and a half years, and the greatest during 1907, when over 500,000 deaths occurred during the first five months, which is the epidemic season. Eight hundred thousand

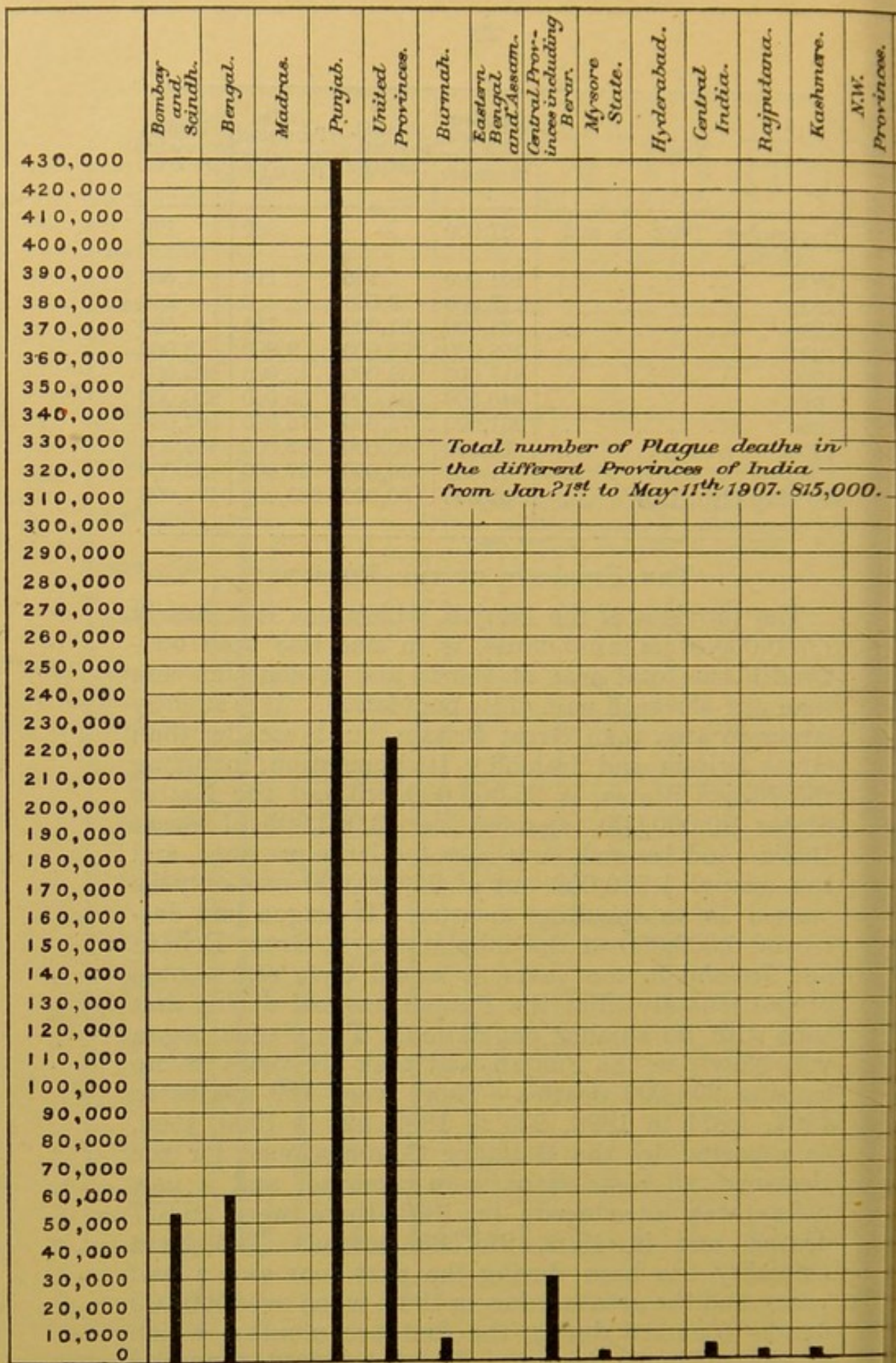


DIAGRAM B.

deaths from plague occurring in Great Britain and Ireland in five months would represent the intensity of the epidemic in the Punjab during the early months of this year. There is no comparison between 800,000 deaths and 54,000, which was the largest epidemic of cholera in England in 1848-49, and which was considered to be appalling in this country. During the week ending May 11th, when the climax of the present year's epidemic in the Punjab was reached, there were 60,000 deaths from plague in that province, which in the British Isles would be represented by 100,000 deaths in one week in an epidemic of the same intensity. The condition of affairs in this country, with 100,000 deaths from plague taking place in one week in the British Isles as the climax of an epidemic which in the course of five months had destroyed 800,000 of its people, would be similar to that now existing in the Punjab at the present time. The state of mind of the rest of the inhabitants of Great Britain and Ireland under such a catastrophe, coming on the top of a devastation which had previously destroyed over 2,000,000, would not be one of calmness and contentment. In the first twelve weeks of the year there were 145,000 deaths from plague in the Punjab; in the next six weeks 286,700 deaths. During these six weeks the plague deaths were as follows:—

Week ending April 6th	..	..	..	34,651 deaths
„ „ „ 13th	..	..	..	39,084 „
„ „ „ 20th	..	..	..	47,047 „
„ „ „ 27th	..	..	..	54,204 „
„ „ May 4th	..	..	..	51,305 „
„ „ „ 11th	..	..	..	60,400 „

These facts will dispel the view that the plague is small thing in India scattered over a vast continent. The effect in the Punjab may be gathered from the following extract from the *Times of India* of June 1st, 1907:—

“A picture of some of the results of the terrible epidemic in the Punjab is given by the *Statesman's* Simla correspondent. To dismiss this epidemic, (he writes) with the statement that the people of the Punjab have been dying from it for some time past at

the rate of 50,000 a week gives but a faint idea of the deserted villages, the crops rotting upon the ground over wide areas for lack of men to reap them, and the breaking up of homes and family life inseparable from such a calamity. The people have learnt to quit their villages and to camp out in the open when the disease appears, and the worst is now over for the year, since the hot winds of May invariably reduce the mortality. But the evil has attained such extraordinary magnitude that it is affecting the whole outlook of the people. In Simla, carpenters have become difficult to procure, because the Jullundur district, where most of them lived, has suffered so terribly. The plague is an undoubted factor, though perhaps not the principal one, in connection with the much discussed unrest. It is also becoming important in changing the relations between population and sustenance, since the survivors inherit the property of those who succumb and grow less inclined in consequence to work for themselves."

In another extract from the same paper it is stated that "natives of Rawalpindi who have relations in the plague-infected villages will not go to tend their sick; others have left the corpses or belongings of deceased relatives to the mercy of the village rather than risk plague. Firewood is not obtainable to burn the dead, so timber from the houses is being utilised, and many Hindus are burying their dead." This last is against the religious views of the Hindus, but their necessity has brought it about.

The concentration in the Punjab, as shown in diagram B, does not mean an equal distribution of the disease over the whole province. The mortality falls with unequal intensity on the divisions and districts into which the province is divided.

Table I. gives the deaths registered in the rural circles of the Punjab with the death-rates of each from 1901 to 1905 inclusive. The statistics are not available for the great epidemic of 1907 or for the lesser one of 1906, but those which are available show the great incidence of plague on certain rural areas. In 1902 the district of Ludhiana was worse affected and had a death-rate from plague of over 70 per 1,000.

More than a fourth of the deaths in the rural circles occurred in this circle. Umballa came next with 30 per 1,000, and Sialkot with 26 per 1,000; one-third of the circles were not infected. In 1903 Gujranwala was the worst infected circle and had a death-rate from plague of 65 per 1,000; Amritsar and Jullundur came next with a mortality of 30 per 1,000 each; seven circles still remained unattacked. In 1904 only one circle remained free from the disease. Shahpur had a death-rate from plague of 74 per 1,000 of its inhabitants, Sialkot 48 per 1,000, Gurdaspur 46 per 1,000, Ludhiana 45 per 1,000, Gujrat 41 per 1,000, and Jullundur 35 per 1,000. In 1905 the recurrence in the rural circles was not quite so severe as in 1904, still Rohtak had a death-rate from plague of 52 per 1,000, Gurgaon 40 per 1,000, and Ludhiana 34 per 1,000. Similar rates are to be noted in the towns of the Punjab. For instance, in 1902, Rupar, a small town in the Umballa district, had a death-rate of 90 per 1,000 of its population from plague. In Jamke, a small town in the Sialkot district, a death-rate of 116 per 1,000 from plague was registered.

In 1902 the Sanitary Commissioner reports that in the minor towns of the Ludhiana district the ravages committed were fearful. Raikot and Machiwara were almost decimated. Jagraon lost 11 per cent. of its population, and Khanna no less than 14 per cent. In twenty-two villages the death-rate from plague ranged from 20 to 40 per cent. of the population. These death-rates, or depopulation of villages, are similar to those which are recorded as having occurred in some of the villages of the Bombay Presidency. There some of the villages lost 33 per cent. of their inhabitants. As is always the case in plague, some places escape lightly in one year, while others are almost depopulated.

Since 1903 special reports on plague in the Punjab have been discontinued, and in that year the administration of plague was handed over to the Inspector General of Civil Hospitals, an officer whose duties in ordinary times are always of an onerous character, and who could have no time to devote to this extra work. Owing to these changes the information is henceforth

human beings. The validity of it has been amply conceded by Koch, Cantlie, Manson, Simond, Hankin, Simpson, as well as numerous other authorities, including many members of the Indian medical and civil services.

It is to be noted, however, that this contention has some opponents. It has been said that in many localities near Bombay the disease ran its course without a single rat being affected; and, on the other hand, there appears to have been an outbreak amongst rats at Kunkhal which ran its course, and terminated without a single human being suffering. In the first case it may be that the incidence upon rats was merely unobserved, and the second obviously does not exonerate the rat from participation in other cases. It has been stated that comparisons have shown that the mortality from plague has been less in rat than in non-rat districts. Even if this be established, it will still remain to be demonstrated that in the latter places the part usually played by the rat was not assumed by some kindred animal. For, as already stated, Clemow has recently reported facts indicating that near Lake Baikal, in Siberia, a species of marmot (*Arctomys Bobac*) has been instrumental in spreading plague. But, apart from debatable points such as these just referred to, it is beyond question that numbers of persons have got plague without handling a plague rat, and numbers of persons have handled a plague rat without getting plague. In any case, how does the bacillus pass from the rat to man?

Suggestions with regard to the site of entry of the bacillus comprise the digestive tract, the respiratory passages, and inoculation. As already stated, infection by way of the gastro-intestinal tract is a controverted question, and infection by way of the air-passages is believed to occur only in pest-pneumonia, which never figures largely in epidemics. Consequently these two paths cannot be invested with any great epidemiological significance. Indeed, most authorities are in accord in regarding inoculation as the principal mode of infection. As you are aware,

the interpretation placed upon the development of the bubo is that the inoculation occurs in the area from which lymph is collected to pass through the affected gland. The great frequency of femoral buboes is regarded as an indication that inoculation most commonly takes place through the skin of the lower extremity, and in China and India this selection was accounted for by the habit of the native population in going barefoot. They were supposed to become inoculated by infected dust through wounds and abrasions on the feet. But it has been found that in countries where such a custom does not obtain the femoral region is still the most common site of the bubo, and consequently the theory of the "nu-pieds" no longer affords a satisfactory explanation. It is obvious, also, that none of the suggestions just referred to throw any light on the undoubted association of rats with epidemics of plague in human beings.

Upon this hitherto obscure feature of the dissemination of plague, we are now in possession of interesting data as the outcome of the researches of Simond.³³ This observer noted that persons becoming plague-stricken after handling a rat did not necessarily develop their bubo in the axilla. As often as not in such cases the bubo was femoral. The same authority states that a plague rat is dangerous or not in accordance with the time that has elapsed since it died. If handled soon after death, plague may follow, but if not touched for some hours, it may then be handled without risk. It was, says Simond, just as if the infection completely evaporated within a few hours after death. Finally, upon this point, Simond observed that in many instances there was, on the area corresponding to the affected gland, a local lesion, a phlyctenule, which he regards as marking the actual site of inoculation, and in which plague bacilli are to be detected. The occurrence of such a phlyctenule is vouched for by several other investigators,³⁴ though not all concur in Simond's interpretation of it. This local lesion is not always apparent, and, in fact, in the majority of cases,

it is not to be found ; but this frequent absence, Simonds contends, is due to the fact that it would only be produced when the inoculated bacilli were of comparatively mild virulence. Under such conditions there would ensue positive chemiotaxis, local leucocytosis and reaction, whereas, if the bacilli were very virulent, the chemiotaxis would be negative, and no such local reaction occur. However this may be, Simond believes that the phlyctenule represents the point at which the bacillus found entry, and that it was produced by something that passed from the body of the rat to that of man, the said something being in his opinion most probably a flea.

He found by observation that perfectly healthy rats harbour very few fleas, and were very expert in removing them, but as they became sick they neglected their toilet, and fleas became more and more abundant upon them, so that they sometimes swarmed upon moribund rats. After death, on cessation of the circulation, and as the body becomes cold, the fleas leave it and seek another host. In this way he explained the " evaporation " of the risk attendant upon handling a dead plague rat. If the fleas from the dead rat reach another rat or a human being, they may inoculate the bacilli they acquired by ingesting the blood of their former host. In this way, according to Simond, the plague spreads from rat to rat, and from rat to man. The man who handles a plague rat may be bitten by the flea, not on the hand or arm, but on the leg, and so the bubo be femoral. So it may happen that a person who has not had to do with a plague rat, may yet be invaded and inoculated by the flea from it. It is enough that plague rats have recently died in the house or place.

By way of further substantiating his views, Simond demonstrated the presence of plague bacilli in the bodies of fleas from plague rats, and produced the disease by inoculating such fleas crushed up with sterilised water. To the still further objection, that the flea may contain bacilli in

the stomach, and yet not give plague by biting, Simond's researches supply the following answer. He placed in a large glass jar a sick rat, and also a healthy animal (rat or mouse), the latter being enclosed in a small cage so as to prevent contact with the sick rat. If he left or placed fleas upon the sick rat, and allowed its body to remain lying in the jar for some hours after death, the healthy animal sometimes developed plague and died; but if he previously removed all the fleas from the rat, and repeated the experiment otherwise precisely as before, the healthy animal did not die, but remained perfectly well.

It must be admitted that Simond supports his flea theory at every possible point, and in doing so has performed a most interesting and suggestive piece of work. It still awaits confirmation by other observers, but meanwhile there is every reason to regard it as perfectly valid. Nowadays we accept the intervention of parasites with regard to many diseases—the mosquito in malaria, the tse-tse fly in African horse-sickness, and the cattle tick in bovine tick-fever; and in none of these is the proof any more complete than that which Simond has furnished with regard to the flea and plague. The theory is perhaps not absolutely exclusive of other agencies. The bacilli have been found in bugs, flies, and ants, but, with the possible exception of the first, it is not likely that these animals play any significant part in plague epidemics. Admitting cases of accidental inoculation, of occasional contagion, of direct passage of fleas or bugs from man to man, and perhaps rarely the operation of some other obscure mode of conveyance, the great bulk of cases is not to be explained in any such way. Simond's hypothesis accounts for most of them and for much else that was formerly mysterious in the epidemiology of plague. The apparent infectivity of linen and clothing and of plague-houses and the influence of poverty, squalor, and dirt may easily be due to the harbourage such things afford for plague fleas. Even if we do not accept the evidence as entirely conclusive, nevertheless it is quite good enough to justify

TABLE II.—MORTALITY FROM PLAGUE IN THE DISTRICTS OF THE PUNJAB FROM 1901 TO MAY 11TH, 1907.

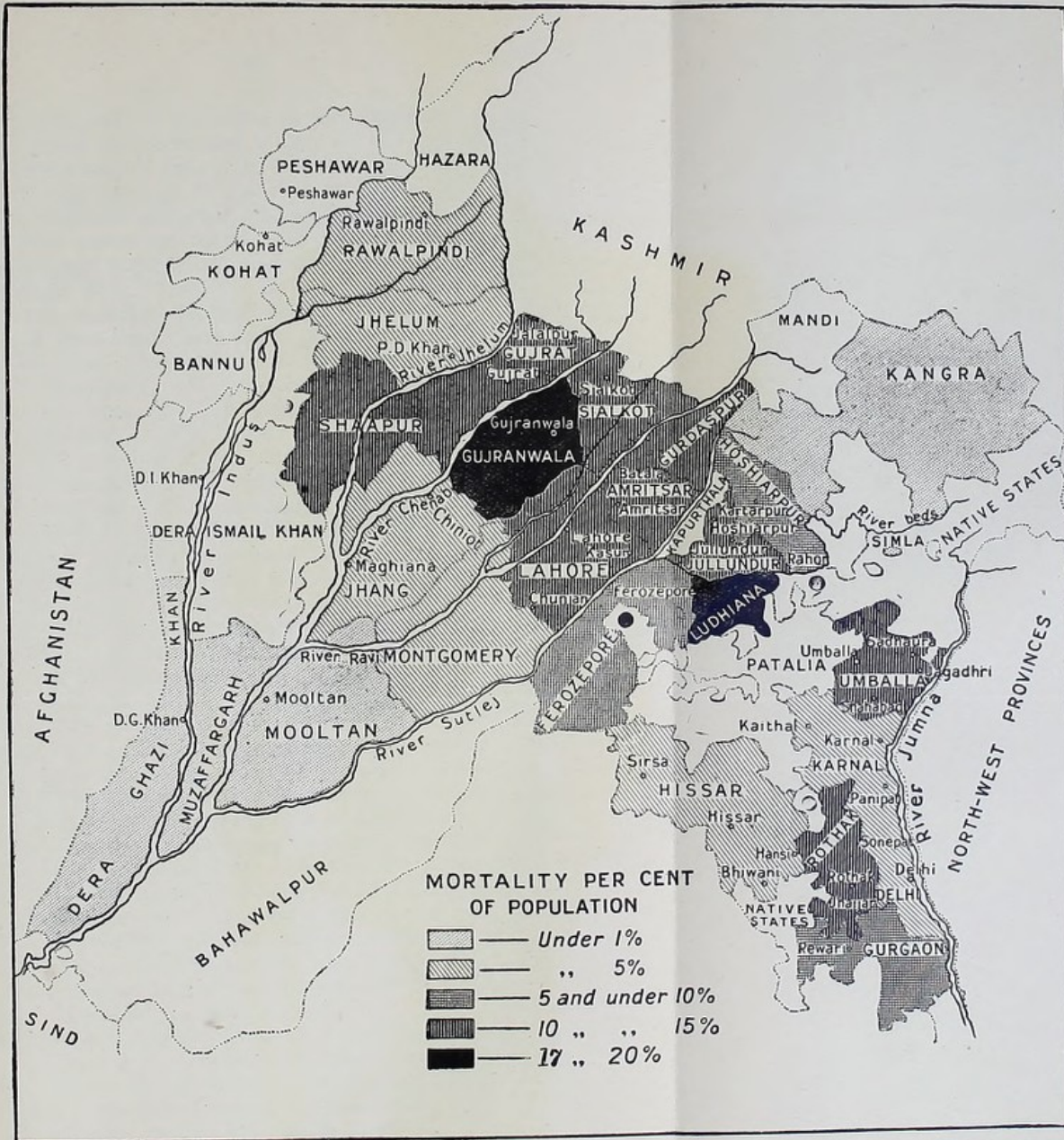
Districts	Population according to census 1901	1901 No. of deaths	1902 No. of deaths	1903 No. of deaths	1904 No. of deaths	1905 No. of deaths	1906 No. of deaths	1907 No. of deaths	Total number of plague deaths from 1901 to May 11th, 1907	Mortality per 100 of population
Delhi Division :										
Hissar..	781,717	—	2	1,772	3,030	16,762	1,555	1,790	24,911	0
Rohtak ..	630,672	—	—	231	4,496	31,952	2,656	26,485	65,820	3
Gurgaon ..	746,208	—	5	3,885	7,170	29,172	105	3,008	43,345	10
Delhi ..	686,998	—	2	9	966	7,352	451	6,092	14,872	5
Karnal ..	883,225	—	569	1,516	2,335	9,997	4,773	8,159	27,349	2
Umballa ..	763,250	154	22,902	6,517	20,262	18,276	2,123	21,376	91,610	3
Simla ..	35,579	—	6	9	3	—	—	1	19	12
Total ..	4,527,649	154	23,486	13,939	38,262	113,511	11,663	66,911	267,926	.5
Jullundur Division :										
Kangra ..	764,441	—	10	12	15	29	71	53	190	.02
Hoshiapur ..	989,782	2,308	12,821	17,436	28,340	18,578	4,362	11,074	94,919	9
Jullundur ..	904,307	3,857	17,364	23,826	32,008	24,118	1,931	31,022	134,126	14
Ludhiana ..	673,097	429	47,671	7,145	33,957	22,183	7,466	21,735	140,586	20
Ferozepore ..	932,206	8	6,426	7,597	10,116	21,831	5,381	20,512	71,871	7
Total ..	4,263,833	6,602	84,292	56,016	104,436	86,739	19,211	84,396	441,692	

Lahore Division :										
Sialkot	1,071,327	3,695	28,258	14,626	23,453	12,244	15,000	44,163	141,439	13
Gujramvala	890,577	1	3,779	44,267	27,593	20,658	6,925	52,904	156,127	19
Montgomery	487,952	—	1	228	403	990	127	3,616	5,365	1
Lahore	1,146,029	180	11,814	24,664	25,734	28,787	10,084	29,462	130,725	11
Amritsar	1,022,438	1	4,191	25,355	22,438	29,931	8,367	16,067	106,350	10
Gurdaspur	936,784	4,325	14,731	5,388	39,993	20,056	12,243	28,940	125,616	13
Total	5,555,107	8,202	62,774	114,528	139,554	112,666	52,746	175,152	665,622	
Rawalpindi Division :										
Gujrat	750,548	—	508	2,906	29,830	14,385	1,269	26,524	75,422	10
Shahpur	524,259	—	9	828	37,278	4,471	205	17,781	60,572	10
Jhelum	498,176	1	—	225	11,066	300	200	10,240	22,082	4
Rawalpindi	517,761	—	1	1,082	774	1,111	1,303	7,746	12,017	2
Attock	460,897	Not included	—	—	23	45	25	2,648	2,741	•6
Total	2,751,641	1	518	5,041	78,971	20,312	3,002	64,939	172,784	
Multan Division :										
Mianwali	424,588	—	—	1	3	2	7	12	25	•005
Multan	697,859	—	13	2	112	44	—	12	183	•02
Jhang	490,266	—	219	2,541	1,819	853	—	781	6,213	1
Dera Ghazi Khan	469,947	—	—	—	53	479	—	—	532	•1
Muzaffargarh	405,656	—	—	—	—	—	34	—	34	•007
Lyallpur	522,144	—	—	—	1,530	759	165	1,881	4,335	•9
Total	3,010,460	—	232	2,544	3,517	2,137	206	2,686	11,322	
Total districts	20,108,690	14,959	171,302	192,068	364,740	335,365	86,828	394,084	1,559,346	7
Total native states				18,629	38,210	54,868	12,055	39,145	162,907	
Grand total				210,697	402,950	390,233	98,883	433,229	1,722,253	

scanty. In 1904, however, there can be gleaned from the few remarks made by the Sanitary Commissioner, when treating of the vital statistics of the province, the havoc which the plague caused in some localities. Thus he says: "As an instance of the fearful increase in the mortality caused by plague, it may be noted that the death rate of the district of Shahpur in April, when plague was most virulent, was *twenty-three times* higher than in August, by which time the disease had entirely disappeared. The total number of deaths in April in that district was 17,889, of which no fewer than 17,012 were ascribed to plague, as against only 781 in August, including one death from plague. The death-rate for Shahpur for April was *415 per mille per annum.*" With this rate in the district of Shahpur as a whole, it is safe to say that similar rates of 20 and 40 per cent. occurred in some of the villages, as were recorded two years previously in the villages of Ludhiana. There was in 1904 an abnormal increase in the total urban death-rate, which the Sanitary Commissioner states was accounted for by plague, and he mentions the high rate of 145 per 1,000 in Hodal, in the Gurgaon district, and of 125 per 1,000 in Miani, in the Shahpur district, whose death-rate from plague was 100 per 1,000 in each case.

If the totals for the five years in the rural circles be taken, it will be seen that the Ludhiana district lost 100,000 of its inhabitants out of 586,000, or more than one in six. Sialkot lost 103,000 out of 994,000, or nearly one out of every nine. Gujranwala lost 101,000, or nearly one in eight of its population. I have not been able to add to these losses in the rural districts those of 1906, which was a comparatively light year, and those of 1907, which has been worse than any of the previous years, but the figures as they stand demonstrate a devastation on an immense scale, and which with the losses of 1906 and 1907, together with what is to come, means a mortality comparable with even that of the Black Death.

Though not able to give the statistics of the rural circles for 1906 and the earlier months of 1907, I am able to give them for the divisions and districts of the



Map showing incidence of mortality from plague from 1901 to May 11th, 1907, on British territory in the Punjab according to districts. Scale 100 miles to the inch.

1903 the Lieutenant-Governor of the province recorded that there had been an increase of crime, and although the effects of the plague had not been immediately apparent he anticipated that trade, agriculture, and education, recruiting and other interests were bound to suffer. These anticipations and more have happened, and the state of Punjab has become socially and politically a serious cause of anxiety. It has recently been announced in the *Times* that there is a deficit of 32 lacs of rupees in the Punjab revenues of last year, and that in many places the crops are standing unreaped because there are no harvesters. The silence of those unharvested fields, together with the figures of mortality, should bring to everyone's imagination a very clear realisation of the awful devastation of the Punjab. Nor are the effects likely to be confined to the Punjab, for there can be no moral and material progress of India as a whole when one of its smaller provinces is being more than decimated, and when there is danger of the disease attacking other provinces with a similar intensity.

It will be recognised from the foregoing facts that the dying millions in India present a problem of the greatest urgency and danger. The plague if left as it has been within recent years to take its own course bids fair in such circumstances to overwhelm not only India but also to be a danger to the world.

MODES OF DISSEMINATION AND CHANNELS OF INFECTION.

Turning to the preventive aspects of plague the question arises, Are the principal modes of dissemination and the channels of infection known? It is now accepted that the importation of plague into a healthy locality can be effected by an infected human being, or an infected rat, or infected clothes. Observations have been so numerous as regards these agencies as to remove all doubt on this point. Dr. E. E. Klein has further shown by some important experiments that infected grain may also be an agent in the importation of the disease. By feeding rats and guinea-pigs with grain which had been contaminated with old cultures of plague, and which was then dried, he was able to

cause plague in those animals, so that grain which has been infected with infective material from plague rats or human beings may, on importation into a healthy seaport, give plague to healthy rats on shore which eat the contaminated portions of the grain. The association of corn ships with plague is a very old one. In recent years the association has been ascribed almost wholly to plague rats on board ship which have left the ship and infected healthy rats on shore, but now infected grain may be added as a likely agent.

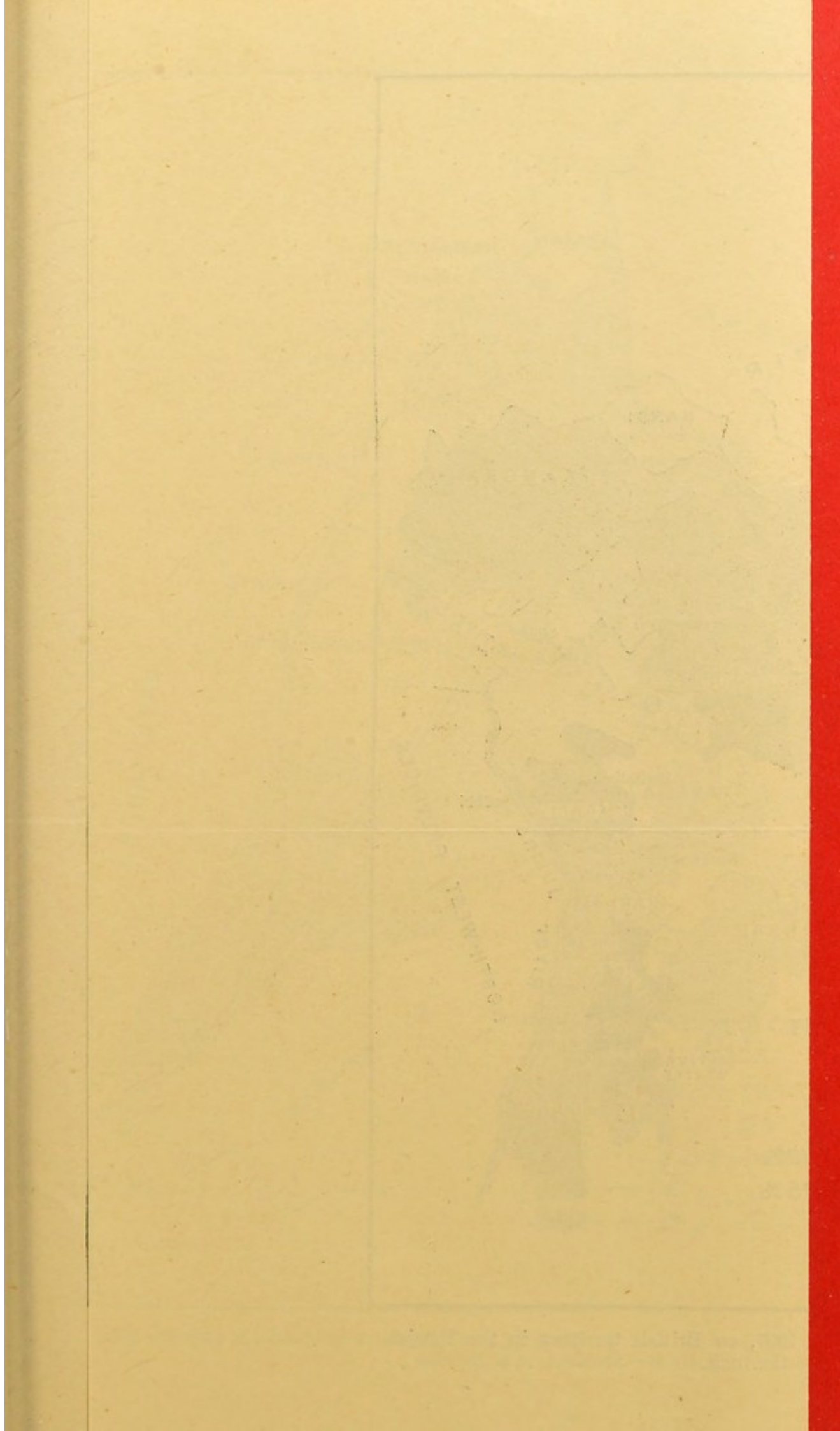
Once imported, the dissemination of the disease is effected by similar agents as those bringing about importation. Rats, clothes, human agency, and food play their respective parts. It is now almost universally admitted that, except in pneumonic cases, rats are the principal agents in the dissemination of the disease, though personal contact, as in typhoid fever, also plays its part. They bring the infection into houses connected with their subterranean passages. In Hong Kong one could trace many of the subterranean passages with their infected rats and their connection with the distribution of the disease in the houses. A systematic bacteriological examination of rats trapped and found dead proved that plague in the rats of the locality preceded plague in man. So constantly did this occur that as soon as plague-infected rats were discovered, measures were introduced as in Cape Town, but on a more extended and systematic basis, of treating the house or locality as plague-infected. In other words, a policy of forestalling plague was adopted. The precedence of rat plague in relation to plague epidemics was observed in Bombay, the Punjab, Calcutta, South Africa, Australia, and Southern China. The value of the Hong Kong observations lay in the direct evidence obtained by scientific and precise methods not only of the direct relationship which the precedence of rat plague bore to human plague, but also of the important *rôle* which the rat plays in the spread of the disease from house to house and in groups of houses. Similar observations were made by Dr. J. Ashburton Thompson, in Sydney, but under different conditions. The Sydney outbreaks are comparatively mild, the mortality being under 40 per cent.,

and consist mainly of bubonic cases with but few septicæmic cases. Probably the type in Sydney was the same as that met with in Cape Town, where one of the marked features was absence of cerebral symptoms and intestinal disorders, differing in this respect from the type met with in Poona in 1897, but which in 1907 seemed to me to have changed, presenting fewer nervous symptoms. The Hong Kong outbreaks are exceptionally virulent, the mortality being over 80 and 90 per cent., and with a large percentage of septicæmic cases.

The problem of the dissemination of the disease by rats is not solved by simply proving that rats are infected with plague in a house or locality before human beings, or by the fact that if measures are taken to dispose of the infected rats human plague will not occur, and *vice versâ*, if no measures are taken, plague will attack some of the inmates of the house. The question naturally arises, How is the infection of the rat transferred to man? There are two views, and the upholders of each have a tendency to claim that theirs is the only way. The more that is learnt of plague the more it is evident that there is no only way.

THE FLEA THEORY.

Dr. Ashburton Thompson had exceptional opportunities of studying the small outbreaks in Sydney, and on that study he came to the conclusion that Simond's theory that the flea on the rat, leaving the rat dead from plague, and then biting man, transfers plague from the rat to man, explained the phenomena connected with plague. That theory, of which Dr. Ashburton Thompson is the champion, has recently received very valuable support in its favour from the very important experiments made by the Indian Plague Commission, and which are the outcome of certain researches by Captain W. G. Liston, I.M.S., to whom much credit is due for his excellent work in this direction. These experiments established first the accuracy of Simond's and Gauthier's and Raybaud's experiments as to the power of infected fleas from plague rats causing plague in healthy rats: 61 per cent. of the white rats, which are very susceptible





to plague, and 52 per cent. of the Bombay rats experimented on contracted plague by the transference to healthy rats of fleas from infected rats. Similarly, guinea-pigs allowed to run free in plague houses in many instances attracted a large number of fleas, most of which were rat fleas, and 29 per cent. of the guinea-pigs contracted plague. Animals in cages protected from fleas by a layer of "tanglefoot" did not contract plague, while animals in cages not so protected developed plague to the extent of 24 per cent. Out of 247 fleas caught on the "tanglefoot," 60 per cent. were human, 34 per cent. were rat, and 6 per cent. were cat fleas.

Plague-like bacilli were demonstrated in the stomach contents of one out of eighty-five human fleas dissected and of twenty-three out of seventy-seven rat fleas. The commission carried the observations a stage further, and by the transference of infected fleas from guinea-pigs started an epidemic of plague among healthy guinea-pigs which was maintained by the introduction of fresh infected fleas.

That the flea is an important agent in spreading plague from rat to rat and in the maintenance of rat epizootic is evident from these experiments. The rat flea, variously named by different observers *Pulex cheopis*, *P. murinus*, and *P. pallidus*, and commonly found on the *Mus rattus*, was the active agent in the transfer of the disease from rat to rat and from rat to guinea-pig. To the extent to which the *P. cheopis* is an agent in keeping up the epizootic in the rat, it will account for the epidemiology of plague, but it is not a necessary deduction from this that *P. cheopis* plays the same active part in the transfer of the disease from the rat to man as it does from rat to rat, though it may be credited with an indirect influence in the maintenance of the disease in man owing to its being an active agent in the dissemination of the disease in rats and possibly in other animals.

There is much in favour of *P. cheopis* playing an active part in the transfer of plague from the rat to man. There can be no doubt that *P. cheopis*, unlike *P. fasciatus*, another common rat flea, bites man. *P. cheopis* is only found occasionally in ordinary circum-

stances on man. As a rule, it is either the human flea or *P. canis* that is usually found on man. Hilger identified 59 per cent. of over 2,000 fleas which he found on man as being *P. canis*, and it may possibly have been this flea which, owing to its wide distribution on rats, dogs, cats, and man, gave rise to the older views that dogs, cats, and fowls from infected houses spread plague even when these animals were unaffected. In certain circumstances *P. cheopis* may be found in numbers on man, such as the instance given by Liston, in which 46 per cent. of the fleas found on the persons of inmates in an infected house proved to be *P. cheopis*.

In Hong Kong in 1902 I was able to infect two monkeys by placing rats which had died from plague and which were covered with fleas in the same cages as the monkeys but in compartments which prevented any possible contact between rat and monkey, but which allowed of a free passage of fleas from rat to monkey. Both monkeys fell ill but recovered. The Indian Plague Commission has in a similar fashion on two occasions succeeded in transferring the plague of the rat to monkeys by the agency of fleas. As it is in the monkey so probably it is the case in man. No direct experiments can be made to prove this, but the accidental infection in man caused by the handling of rats dead from plague and on which Simonds first founded his theory would appear to bear the interpretation given them by the laboratory experiments.

On the other hand, taking the most liberal interpretation of the flea theory, based on the experiments mentioned, it is doubtful whether the flea theory will account for more than a certain percentage of the fatal bubonic cases, which may vary in different circumstances in different localities. Out of ten experiments with monkeys by the Indian Plague Commission eight failed, and in my own experiments the monkeys recovered. Moreover, the fact that infants under one year of age are more or less immune to plague militates against the flea being as important an agent in the causation of human plague as of rat plague. The incidence on infants is very small. This has been shown by Lieutenant-Colonel C. J. Bamber, I.M.S.,

in the different Punjab epidemics. This immunity is shared with the aged. Fleas probably are not attracted to old people, but the same cannot be said with reference to infants who sit, lie on, and crawl about the floor. The food of infants fed as a rule at the breast of the mother differs from that of the adults in that it is pure and not subject to contamination with plague virus, and herein probably lies the explanation of the immunity of the infant.

THE FOOD THEORY.

The difference in the type of the disease in Sydney as contrasted with Poona and Hong Kong has already been mentioned. More *post-mortem* examinations are made on plague cases in Hong Kong than in any other part of the world, and it is on the observations there, both on man and animals, that the theory has been formulated that the ingestion of food contaminated with the plague virus is the cause of septicæmic cases of plague.

Wilm, in 1896, found that in 20 per cent. out of 150 necropsies the mucous membrane of the stomach or intestines showed lesions with hæmorrhages, and he was successful in causing plague in fowls by feeding them with plague material and with pure cultures of the plague bacillus. He also succeeded in infecting a pig fed with the spleen of a man who had died from plague. In 1897 the German Commission in Bombay was successful in causing plague in rats, a mongoose, a squirrel, and monkeys by feeding experiments, but failed with mice, guinea-pigs, dogs, and pigs. The Austrian Commission was successful in similar experiments with guinea-pigs, rats, mice, and cats, but failed with dogs, pigeons, hens, and a mongoose.

In 1902 I had the opportunity of seeing, with Dr. W. Hunter, a large number of necropsies on plague cases in Hong Kong, and we were able to confirm the great frequency with which the intestines are the seat of primary hæmorrhagic lesions and the mesenteric glands swollen and hæmorrhagic. Later, Dr. Hunter has given a detailed description of the pathological changes which are observed in the alimentary canal, and which are practically present in

all the septicæmic cases of plague. The stomach shows well-marked congestions and hæmorrhages; some of the hæmorrhages may occasionally be of the size of a dollar piece. The changes met with in the small intestines are even more severe than those in the stomach. Petechial hæmorrhages and blood extravasations with necroses, forming not infrequently superficial ulcers, are common. Peyer's patches and the solitary follicles are swollen, and may be hæmorrhagic, and in some parts inflammatory changes extend through the walls of the intestine. The mesentery is frequently affected by extensive hæmorrhages, and the contained lymphatic glands are enlarged and hæmorrhagic. The lymphatic glands standing in relation to the ileum and cæcum are almost always affected. They are frequently double their ordinary size, and on section are œdematous, with minute blood extravasations into their parenchyma. With Dr. Hunter and Dr. Matsuda, a Japanese medical man lent to the Government of Hong Kong by Japan, I was able to carry out a series of feeding experiments which established that poultry, calves, pigs, sheep, rats, and a monkey contracted plague by feeding. We failed to cause plague in dogs by feeding. These observations on men and on animals led me to the conclusion that septicæmic plague is in most cases contracted by the alimentary canal; an additional fact which lends support to this view is the frequency of abrasions and denudations of the alimentary canal in Asiatics. Dr. H. Fraser, who is engaged in a research on the condition of the intestines, showed me in his laboratory at Kuala Lumpur, in the Malay States, microscopical specimens of the intestines of Chinese and Indians in which he had found over 50 per cent. with abrasions or ulcers. Dr. Hunter has also shown that when premonitory symptoms of plague do manifest themselves the patients frequently suffer from gastric and intestinal disorders, with diarrhœa, and in these cases examination of the blood shows a septicæmic infection.

More decisive than even the foregoing experiments on animals are those made by Dr. Klein in this country, because of the convincing histological work

which he has associated with them. He has proved beyond all question of dispute that the plague bacilli taken in contaminated food multiply while the food is in the intestines, enter through the lymph channels or lacteals of the intestines, and invade the blood in swarms. The only qualification is that the microbes shall be so protected as not to be affected by the gastric juice.

LECTURE III.

Delivered on June 25, 1907.

IMMUNISATION AGAINST DISEASE.

MR. PRESIDENT AND FELLOWS,—The next question from a preventive aspect is whether there is a prophylactic against plague similar to that of vaccination against small-pox, and if so, what is its value. The question naturally leads to a consideration of Haffkine's prophylactic against plague and of methods of artificial immunisation. Jenner's great discovery lay in the fact that he ascertained that the passage of the small-pox virus through the cow fixed its properties in such a manner that the immunising effects of the small-pox virus were retained, while its power of producing the disease was destroyed. The defects of inoculation with the small-pox virus consisted in the danger to the inoculated which sometimes attended the operation and in the risk of infection which sometimes spread from the inoculated to other persons. Notwithstanding these disadvantages, inoculation was practised as the lesser evil, because in the majority of cases its effects were comparatively mild, and it conferred a very high protection. Inoculation against disease is thus a very old method of protection. In some of the ancient shastras written contemporaneously with the works of Menoo, inoculation is mentioned as being practised as a preventive or modifier of small-pox. Even inoculation against plague has been practised among the Turks.

The Brahmins who performed the inoculations against small-pox in India, instituted certain procedures to avoid the defects as much as possible. They made it a point to inoculate, if possible, all the children in the village at the same time, so as to prevent natural infection; they selected the virus from a

discrete case, and they usually kept it several days before inoculating it into individuals, for they found by experience that it produced a milder disease when thus kept than when directly transmitted from person to person. In later times such precautions were often relaxed, with results not nearly so satisfactory. In China the inoculations against small-pox were often practised by ignorant men, and instead of the small-pox virus being inoculated through the skin, which generally gives a mild attack, it was not infrequently placed in the nostrils, and a very severe attack of the disease usually followed. When in China I came across an instance of this kind, where some seventeen persons had been inoculated in this manner, and where the results were serious.

The older methods of inoculation, whether for small-pox or plague, depended on the employment of crude material containing the living germs of the disease, and over these there was little or no control. Sometimes the material was efficacious and harmless, at other times it was dangerous. There was also risk of the method, while protecting the individual inoculated, spreading the disease to healthy persons. The discoveries of Jenner, Pasteur, and Haffkine have introduced new methods by which the material employed is fixed in strength, protective and harmless to the individual, does not spread the disease, and is fully under control.

HAFFKINE'S CHOLERA VACCINATION.

There is a difference between the cholera and plague inoculations introduced by Haffkine. In cholera a living vaccine is employed; in plague a devitalised or chemical vaccine is used. The cholera vaccine needs to be fixed in its strength in order that the microbe shall behave constantly in the same manner when injected alive into man. It was the non-recognition of this fundamental principle which led to Ferran's failure in Spain. He practised inoculation against cholera on the same principle as the old inoculations against small-pox. The crude microbe isolated from a cholera patient was employed without fixing its strength. In Haffkine's method of inoculation against cholera

there are two vaccines. The cholera microbe is first fixed at a high stage of virulence by passing through animals, and is maintained at its high strength by the same process. It is necessary to mention that the cholera microbe requires air for its life, and accordingly in the process of passing it through a succession of animals it is necessary to alternate this procedure with aeration of the microbe for some hours, otherwise it will die. It is in this way that the strong vaccine is obtained. But as this vaccine when injected under the skin of animals is apt to produce a slough, an attenuated microbe is used as a first vaccine. The attenuation is attained by a prolonged aeration and exposure to a continuous high temperature.

The advantage derived from using a living vaccine is that the immunity is higher and of longer duration. The disadvantage is that it has always to be prepared afresh by a bacteriologist, and consequently difficulties arise in its preparation and distribution over large and numerous areas, whereas a devitalised or chemical vaccine can be preserved for a considerable time, and sent out to great distances and administered by any physician who knows how to employ it aseptically.

Toussaint was the first to introduce chemical vaccines. He employed a vaccine of this kind against anthrax prepared from the heated defibrinated blood of dead animals. The method worked well as long as there were no spores in the blood. The heat to which the blood could be subjected without being coagulated—viz., 57° C.—would not destroy spores, so that if these were present, and animals were inoculated, the result was the death of the animals and the danger of spread of anthrax to other animals.

Many experiments were tried on similar lines by others with different kinds of microbes and on different animals, but the immunity obtained by such chemical vaccines was so short-lived that the methods could not be used for practical purposes, and so it happened that up to the time of the cholera inoculations inclusive all vaccinations were done with living vaccines.

HAFFKINE'S PLAGUE INOCULATION.

When the problem of preparing a vaccine against plague presented itself, Haffkine, with his experience of the cholera vaccine, quickly realised the importance of endeavouring to discover a chemical preparation of practical utility. The reason for this was the distribution of the plague in numerous villages and small towns, and the impossibility of obtaining a sufficiently large number of bacteriologists to prepare and use a living vaccine. With these facts in front of him Haffkine pursued several lines of research. One of these was to vary the microbial preparation and to study the effect on each of them of different processes of sterilisation. Artificial cultures of the microbe, the blood and exudation of animals dead from plague, and the pulp of their different organs were taken and subjected to heating, drying, chloroform, carbolic acid, lactic acid, or essential oils.

Inoculation with the dried powder of pulverised organs and blood of animals dead from plague was found to be by far the most effective. A few years ago Dr. Klein made a very careful investigation in this direction, and was successful in preparing a powder possessing very high immunising properties. In India, however, dying animals are rapidly invaded with intestinal vibrios and bacilli, and the heating and drying which were employed to devitalise the plague microbe were not sufficient to kill the spores of these extraneous microbes, so that the same difficulty met with by Toussaint recurred here in another form. Sometimes also the powder appeared sterile in culture, but when injected into an animal killed it, plague bacilli being present in its blood; at other times the animal died apparently from toxins, no microbes being found. When the animal did survive it was very thoroughly vaccinated, but for the reasons mentioned this method was set aside.

The most practical method of preparation was to use artificial cultures and sterilise them by heat, but

it was found that the animals naturally susceptible to plague, such as rats, guinea-pigs and monkeys, could not be vaccinated by this preparation or required many injections extending over several weeks before any immunity was established. Experiments, however, showed that an animal not naturally susceptible to plague—viz., the rabbit, which possesses a relatively high degree of resistance even to injected plague—could be rendered immune with this chemical vaccine. Influenced by this circumstance, and not deterred by the other, Haffkine determined to ascertain whether man could not be immunised in a similar way to the rabbit.

On *a priori* reasoning it seemed improbable, but the experiment first made in the outbreak of plague in His Majesty's House of Correction at Byculla in Bombay, proved the possibility of such immunisation. This epidemic only lasted a week after the inoculations, but still it seemed to show that during that short time benefit had accrued from the use of the prophylactic. The result obtained at the Byculla jail was subsequently confirmed by many experiments made under varied conditions and on a larger scale, and finally, it has been established that the immunity in man is not only real and of a satisfactorily high degree, but lasts for a considerable time.

These two circumstances demonstrated for the first time the practicability of immunisation by a chemical vaccine. The success of the method encouraged a trial of immunisation on similar lines against typhoid fever, and this also appears to have been attended with successful results.

Experience of the effect produced by the cholera vaccines in India from 1893 to 1896, demonstrated that immunity was obtained against attacks of cholera, but when the inoculation failed, and the person inoculated was subsequently attacked, the fatality was practically the same as among those not inoculated. This result pointed to antimicrobial immunity being obtained, but not to antitoxic immunity, and appeared to be related to the fact that the cholera vaccine consisted of the bodies of living bacilli obtained by cultivation on solid media. Haffkine realised that the defect

attaching to the cholera vaccines should, if possible, be remedied in the production of the plague prophylactic, and endeavoured to prepare a material which would give, not only an immunity against attack, but also at the same time diminish fatality when an attack occurred.

In the case of microbes producing extra cellular toxins, such as diphtheria, antitoxic properties are obtained in animals by injection of the toxins. Plague cultures in fluid media do not show the presence of any appreciable toxins in the filtrate, but Haffkine observed that when he injected into animals sterilised old fluid cultures of the plague bacillus, he obtained a reaction which he could not obtain to the same extent when using the microbes and the filtrate separately. This appeared to indicate that the fluid possessed properties of its own. It encouraged him to try the combination of the microbes and the fluid, which later was proved to be a success. The method adopted was to use old cultures rich in bacilli and their secretions. A suitable medium for obtaining such cultures was peptone broth, to which were added a few drops of butter or oil. By the end of six weeks the culture is ripe for use, and its purity is ascertained by drawing off a small quantity and subjecting it to the tests already described in the first lecture. The culture is then heated at from 55° to 60° C. for twenty minutes, with the result that the microbe is devitalised. The prophylactic then becomes a chemical drug, with fixed properties, and can be used in measured doses like other drugs. The preliminary fixation of the biological and pathogenic properties of the microbe is, under such conditions, not an essential process, as in the case of cholera and small-pox, where living vaccines are introduced into the system.

The dosage of the prophylactic was determined by careful observations of its effects on man, which led to the adoption of the principle gathered from the study of the results of the cholera inoculations in India. This principle consists in regulating the dose with the view of producing an average temperature of 101° F. The same dose in different individuals gives rise to different ranges of temperature. Following the above

CLASS I. TABLE A.—OBSERVATIONS ON THE WORKING OF HAFKINE'S SYSTEM ON A SMALL SCALE, SPECIAL OBSERVATIONS BEING CARRIED OUT ON RESTRICTED COMMUNITIES.

Name of locality	NON-INOCULATED						INOCULATED							
	Non-inoculated	Cases	Percentage of cases to population	Deaths	Percentage of deaths to population	Proportion per cent. of deaths to cases	Inoculated	Cases	Percentage of cases to population	Deaths	Percentage of deaths to population	Proportion per cent. of deaths to cases	Percentage of saving in cases	Percentage of saving in deaths
(1) Byculla jail	172	12	7.0	6	3.5	50.0	147	2	1.4	—	0	0	80.0	100.0
(2) Umerkhandi jail	127	10	7.9	6	4.7	60.0	147	3	2.0	—	0	0	74.1	100.0
(3) Undhera village (plague infected houses)	64	27	42.2	26	40.6	96.3	71	8	11.3	3	4.2	37.5	73.3	89.6
(4) Hubli (mill)	75	—	—	20	26.66	—	1,098	—	—	30	2.7	—	—	89.7
(5) Hubli (employees of Southern Maratha Railway)	760	35	4.6	21	2.7	60.0	1,260	11	0.9	2	0.2	18.2	81.03	94.1
(6) Dharwar jail *	—	—	—	—	—	—	374	—	—	—	—	0	—	100.0
(7) Broach (Parsee population)	763	9	1.2	5	0.6	55.6	1,080	2	0.2	1	0.1	50	83.3	85.7
(8) Broach (tailors' camp)	135	10	7.4	6	4.4	60.0	90	—	0	—	0	0	100.0	100.0
(9) Belgaum†(49th Battery R.F.A. Native followers)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(10) Belgaum (Army Hospital Corps, 1897)	3	2	66.7	2	66.7	100.0	80	—	0	—	0	0	100.0	100.0

(10) Belgaum Corps, 1899)	(Army Hospital	5	1	20.0	1	20.0	100.0	79	2	2.5	2	2.5	100.0	87.3	87.3
(11) Major Forman's servants ..		2	1	50.0	1	50.0	100.0	28	—	0	—	0	0	100.0	100.0
(12) Bulsar Shanchis (oil pressers)		35	4	11.4	4	11.4	100.0	261	7	2.7	4	1.5	57.1	76.6	86.6
(13) Colaba ward (Chawl), Bombay		32	19	59.4	12	37.5	63.2	21	1	4.8	—	0	0	99.0	100.0
(14) Poona, Yerowda jail †		—	—	—	—	—	—	—	1	0.06	0	0	0	—	—
(15) Aden—Jewish community (31 households infected)		179	44	24.6	29	16.2	65.9	246	19	7.7	8	3.3	31.2	68.3	79.5
(16) Aden (special prison) ††		2	2	100.0	1	50.0	50.0	—	0	0	—	0	0	100.0	100.0
(17) Aden (Crater Plague Hospital)		—	263§	—	163	—	61.9	—	21§	7.0	—	—	33.3	—	—
(18) Kirkee, near Poona, 1906 ..		12	6	50.0	3	25.0	50.0	1,300	5	0.4	1	0.1	20.0	99.2	99.7

* Four deaths occurred among the prisoners before inoculation. The entire population was inoculated. One case, which recovered, occurred two days after inoculation.

† Population 334. Plague continued for thirty-seven days, and twenty-three cases and seventeen deaths occurred. Gradually the whole population was inoculated, and none of those inoculated were attacked.

‡ Population 1,661. Plague continued for thirteen days, and three cases and three deaths occurred in those who had not been inoculated; 1,658 were inoculated by the thirteenth day; of these one was attacked, but recovered. There were no further cases.

§ All the prisoners were inoculated excepting two; these two were attacked, one of whom recovered. When inoculation completed, no cases, although rats were dying from plague.

§ Admissions.
These observations were made in places where non-inoculated people had between 1.2 and 100 per cent. of cases, and between 0.6 and 66.7 per cent. of deaths, with a proportion of deaths to cases varying between 50 and 100 per cent. The inoculated people of the same places had between 0 and 11.3 per cent. of cases, and between 0 and 4.2 per cent. of deaths, with a proportion of deaths to cases varying between 0 and 57.1 per cent. The number of cases among the inoculated was reduced by between 68.3 and 100 per cent., and the number of deaths by between 79.5 and 100 per cent., as compared to the incidence of attacks and deaths among the non-inoculated people of the same place.

standard, it is generally observed that in one-third of the inoculated the temperature may rise to 102° F. and above. This proportion should not be exceeded. The thermometer is thus used as the indicator of the reaction. There is no testing of the blood in plague or cholera inoculation for the purpose of ascertaining what dose shall be given. The information obtained by the thermometer has been found to be a reliable guide, and supplies a very simple and practical method of regulating the dose. It is a notable fact that in cholera and plague inoculations no instance has been observed of the inoculated groups having been rendered by the inoculation at any time more susceptible to these diseases than the uninoculated.

THE RESULTS OF THE USE OF THE PROPHYLACTIC.

The harmlessness of the prophylactic was first established by the inoculation of several hundred volunteers, European and Indian. Then its protective effect was ascertained for the first time at the height of an outbreak of plague at the Byculla jail, and certain facts were observed by Haffkine which enabled him to arrive at some very important conclusions. These were: (1) that one injection of 3 cc. of the prophylactic was sufficient to protect during an existing epidemic; (2) that inoculation was powerless to arrest the disease in those in whom the symptoms have already appeared or develop in a few hours after inoculation; (3) that the inoculation mitigated or aborted the disease in those who were in the incubation stage, and had been infected three or four days previously; and (4) that the prophylactic, unlike the vaccines for cholera, rabies, anthrax, or small-pox, exercised its protective effect in less than twenty-four hours, acting in this respect with a rapidity which was only known in antitoxic sera.

Of these deductions, that relating to the effect of the vaccine on individuals in the incubation stage, and its power of arresting the development of infection or mitigating the disease, appears to be the most incredible, particularly in view of the shortness of the incubation period in plague. Calmette and his co-workers, as well as other bacteriologists, asserted that

an individual inoculated, not only in the incubation period, but also a short time before infection, would succumb to the disease, and recommended that no "contacts," or persons exposed to infection, should be inoculated. The Indian Plague Commission of 1889, though not endorsing this view, was of opinion that inoculation was not likely to effect any protection for the first five days, and was against Haffkine's conclusion as to the benefit of the inoculation in the incubation period. Subsequent study of the subject, however, induced Sir Almroth E. Wright to adopt Haffkine's views, and it is in conformity with the results obtained by Haffkine's inoculation in the incubation stage of plague that he based his method of treating with vaccines patients suffering from furunculosis, sycosis, acne, and other bacterial infections. The fact of the prophylactic immunising so rapidly and being beneficial in the incubation stage, not only excludes the danger that was feared, but allows of the application of the prophylactic in infected houses and localities, and generally during the prevalence of an epidemic.

Later observations have fully confirmed Haffkine's conclusions, which stand to-day without modification. It is not from observations on animals, but from observations on man, that the question as to the action of Haffkine's prophylactic has to be worked out and has to be judged. This test has now been applied in many places, and under various conditions, and always with the same successful result. The observations are divisible into two classes—viz., those that have been made on a small scale in restricted communities living under special administrative and medical control, and those made on a large scale. Owing to the circumstances in which the first class, conducted on a small scale, were carried out, and which permitted of the results being carefully watched and thoroughly checked, they possess a special value on account of their exactness and precision.

The subjoined Table A shows the incidence of plague cases and plague deaths in some eighteen small communities under careful control, where a part of the inhabitants were inoculated and a part remained not

CLASS II. TABLE B.—OBSERVATIONS ON THE WORKING OF THE SYSTEM ON A LARGE SCALE.

Name of locality	NON-INOCULATED						INOCULATED							
	Non-inoculated	Cases	Percentage of cases to population	Deaths	Percentage of deaths to population	Proportion per cent. of deaths to cases	Inoculated	Cases	Percentage	Deaths	Percentage	Proportion per cent. of deaths to cases	Percentage of saving in cases	Percentage of saving in deaths
Mora	580 (about)	26	4.5 (about)	24	4.1 (about)	92.3	419	7	1.7	—	0	0	62.7 (about)	100.0
Damaun	6,033 (about)	—	—	1,482	24.6	—	2,197	—	—	36	1.6	—	—	93.4 (about)
Lanowli	377	78	20.7	57	15.1	73.1	323	14	4.3	7	2.2	50.0	79.1	85.7
Kirkee, in 1897	859	143	16.6	98	11.4	68.5	671	32	4.8	17	2.5	53.1	71.4	77.9
Undhera village,	437	27	6.2	26	5.9	96.3	513	8	1.6	3	0.6	37.5	74.8	90.2
.. whole population														
Khoja community in Bombay, 1898	9,516 (about)	—	—	77	0.8 (about)	—	3,814	—	—	3	0.08	—	—	90.3 (about)
Hubli	17,786	—	—	2,348	13.2	—	24,631	—	—	388	1.3	—	—	89.6
Dharwar (town)	16,848	1,100	6.5	889	5.3	80.8	4,231	129	3.04	54	1.3	41.8	52.2	75.7
Gadag (town)	4,163	278	6.6	216	5.2	77.7	13,004	193	1.5	83	0.6	43.0	77.7	87.6
Belgaum (cantonment)	4,558	506	11.1	346	7.59	68.4	4,842	78	1.6	40	0.83	51.3	83.8	89.1

Ahmednager (district)	8,794	563	6.4	415	4.7	73.7	2,493	70	2.8	31	1.2	44.3	56.2	77.0
Aden (Jewish community)	982	83	8.4	65	6.6	78.3	1,190	23	1.9	8	0.6	34.7	77.0	89.7
The Punjab:														
1897-1900	—	—	—	—	—	60.99	306,730	—	—	—	—	36.55	—	—
1900-1901	—	—	—	—	—	60.59	197,278	—	—	—	—	36.50	—	—
1901-1902	3,909,326	266,700	6.8	173,732	4.4	65.14	235,776*	881	0.4	209	0.1	35.07	94.5	97.1
1902-1903	—	—	—	—	—	60.1	505,849	—	—	—	—	30.47	—	—
Re one portion of the inoculated in 1902-03	639,630	49,433	7.7	29,723	4.6	60.1	186,797	3,399	1.8	814	0.4	23.9	76.5	90.6
Aden, 1905..	1052	368	34.9	294	27.9	78.6	898	37	4.1	14	1.6	37.8	88.2	94.4

* Besides 32,789 in Punjab native states.

These observations refer to places where the non-inoculated part of the population had between 4.3 and 34.9 per cent. of cases and between 0.8 and 27.9 per cent. of deaths, with a proportion of deaths to cases varying between 60.1 and 96.3 per cent. The inoculated part of the population had between 0.4 and 4.8 per cent. of cases and between 0 and 2.5 per cent. of deaths, with a proportion of deaths to cases varying between 0 and 53.1 per cent. The number of cases among those inoculated was reduced by between 52.2 and 94.5 per cent., and the number of deaths by between 75.7 and 100 per cent., as compared to the incidence of attacks and deaths among the non-inoculated inhabitants of the same localities. The results observed in the inoculations made on a large scale were therefore substantially the same as those obtained in special observations made for study in restricted numbers of people living under special administrative and medical control.

inoculated ; most of them are taken from the reports of Colonel W. B. Bannerman, I.M.S. The table shows their comparative liability to attack and death and the percentage of saving in cases and deaths among the inoculated as compared with the non-inoculated.

In the Byculla jail, out of 172 non-inoculated there were twelve cases of plague, six of which proved fatal, while among 147 inoculated there were only two cases and no deaths—that is, among the non-inoculated 7 per cent. of the population were attacked and 3·5 per cent. of the population died, and the proportion of deaths to cases was 50 per cent., whereas among the inoculated only 1·4 per cent. of the population were attacked, and there were no deaths. The percentage of saving in cases was accordingly 80 per cent., and in deaths 100 per cent.

Again, in Umerkhadi jail, out of 127 persons not inoculated there were ten cases with six deaths, whereas among the inoculated there were three cases and no deaths—that is, among the non-inoculated 7·9 per cent. of the population were attacked and 4·7 per cent. of the population died, with the proportion of deaths to cases of 60 per cent., whereas among the inoculated there were only two per cent. of the population attacked, and none died. The percentage of saving in cases amounted to 74 per cent., and in deaths to 100 per cent.

The results given in these first two practically represent the results in the others ; for instance, if the employees of the Southern Maratha railway be taken, it will be observed that out of 760 not inoculated thirty-five cases occurred with twenty-one deaths, whereas out of 1,260 inoculated eleven cases occurred with two deaths—that is, among the non-inoculated 4·6 per cent. of the population were attacked and 2·7 per cent. of the population died with the proportion of 60 per cent. of deaths to cases, whereas among the inoculated there was 0·9 per cent. of cases to the inoculated population and 0·2 per cent. of deaths with a proportion of deaths to cases of 18·2 per cent. percentage of saving in cases amounted to 81·03 per cent., and of saving in deaths to 94·1 per cent.

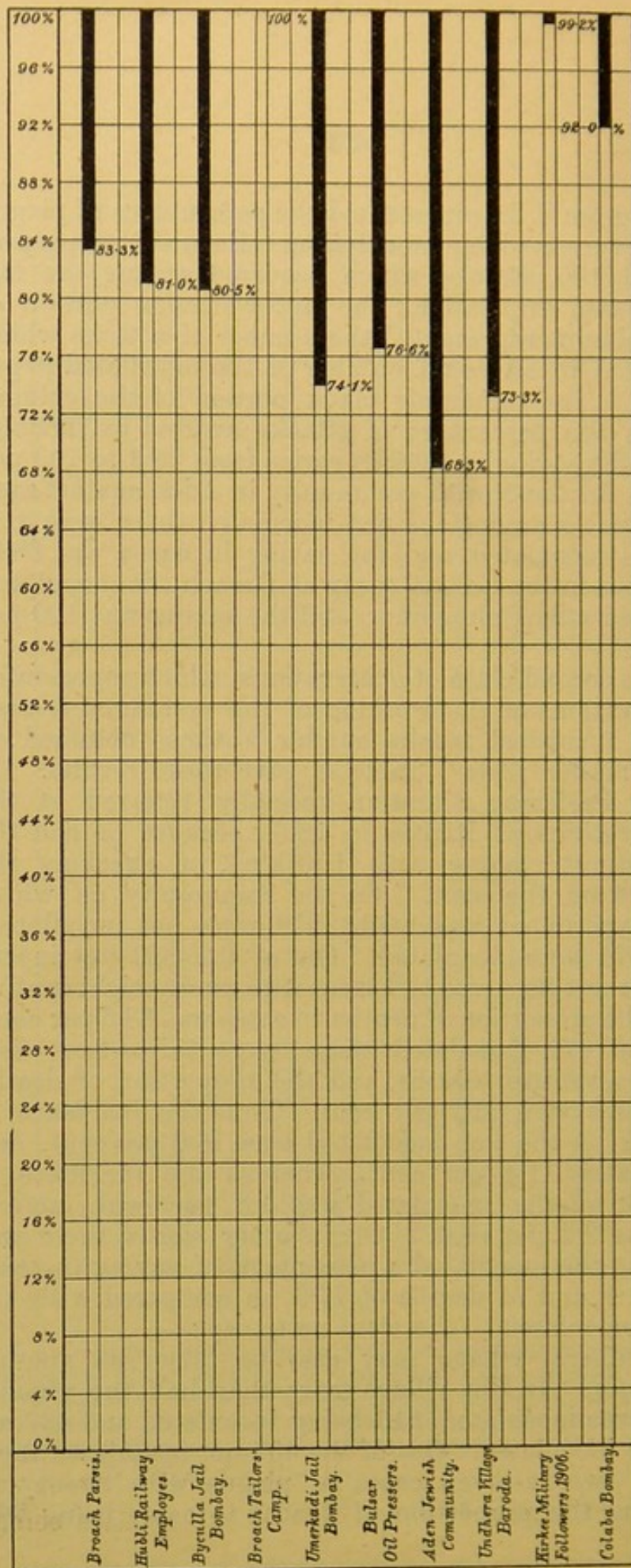
Among these eighteen observations there are several

where the whole community was inoculated, with the result that the plague was arrested. Thus in the Yerowda jail, Poona, plague appeared, and in thirteen days caused three cases, which were fatal. By the thirteenth day the whole of the occupants, consisting of 1,658 persons, were inoculated, one of whom was attacked, but recovered, and there were no further cases. In the Aden Prison all the prisoners were inoculated except two; these two were attacked with plague, and one recovered. When inoculation was completed no cases occurred, although rats were dying from plague.

Summing up these experiments as a whole, they were made in places where the *non-inoculated* people had between 1.2 and 100 per cent. of cases, and between 0.6 and 66.7 per cent. of deaths, with a proportion of deaths to cases varying between 50 and 100 per cent. The *inoculated* people of the same places had between 0 and 11.3 per cent. of cases, and between 0 and 4.2 per cent. of deaths, with a proportion of deaths to cases varying between 0 and 57 per cent. The number of cases among the inoculated was reduced by between 68.3 and 100 per cent., and the number of deaths among the inoculated was reduced by between 79.5 and 100 per cent., as compared to the incidence of attack and deaths among the non-inoculated people of the same places.

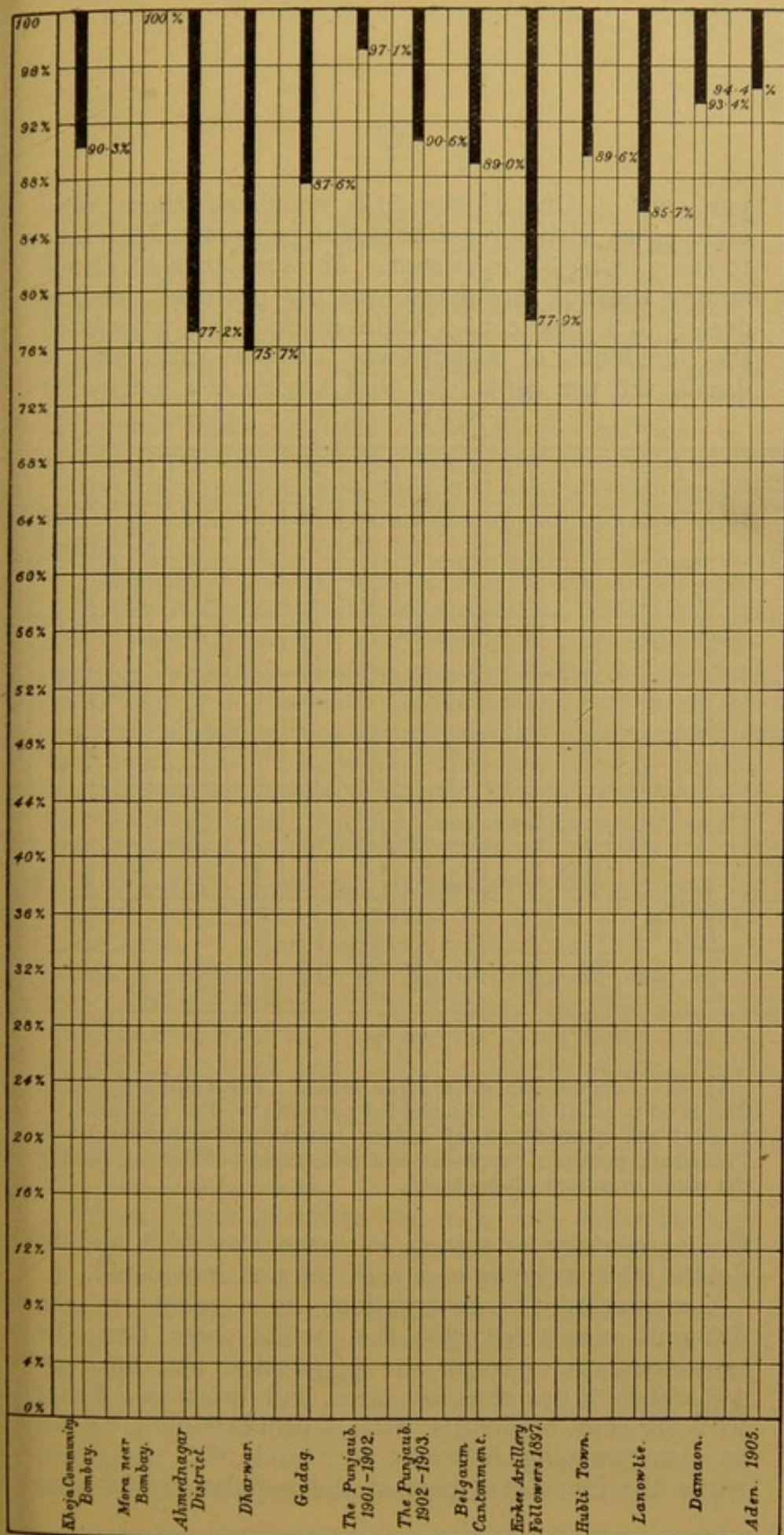
The conclusions derived from these observations will be more clearly followed if the comparative results are given in a graphic form and the smaller numbers excluded.

[Professor Simpson here showed upon the screen several diagrams dealing graphically with these figures. In Diagram I. A the most instructive epidemics had been taken which illustrated different degrees of severity on the population, the incidence of plague varying from 1.2 to 59.4 per cent. on the non-inoculated population, and the incidence on the inoculated from 0 to 11.3. In general the incidence of attack on the inoculated corresponds to the severity of the epidemic, but this is not uniformly the case, for in a few the inoculated show a striking immunity in the midst of very severe epidemics.



I. D.

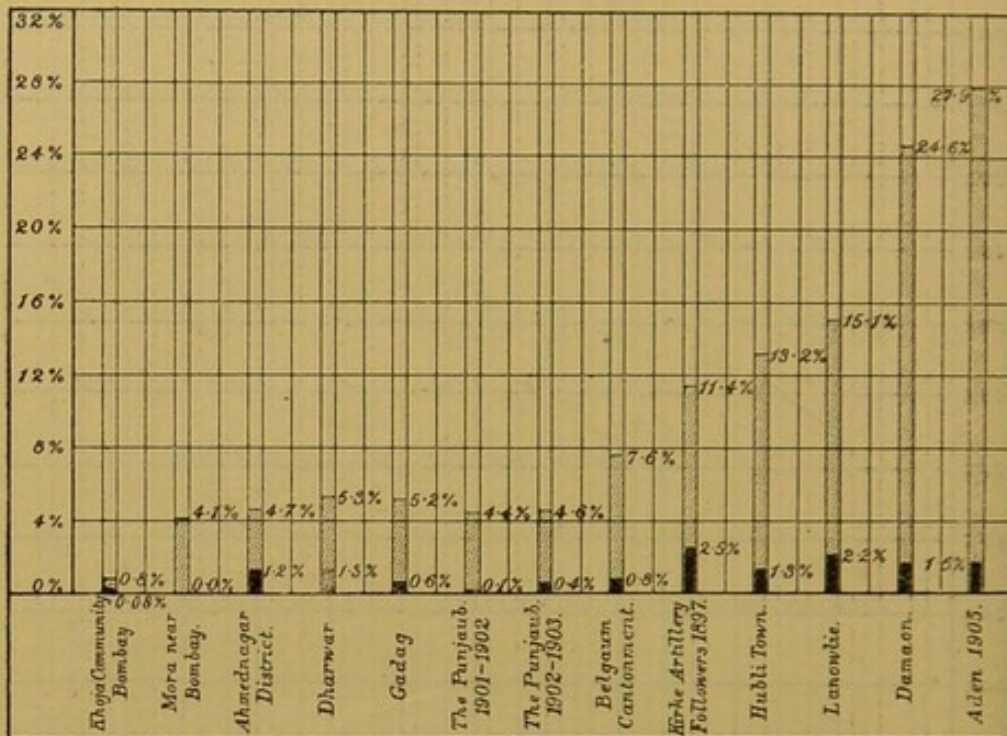
I. D.—Inoculation in small, well-defined communities.
 Percentage of plague attacks averted by inoculation.



II. E.

II. E.—Inoculation on a large scale. Percentage of plague deaths averted by inoculation.

per cent. Out of the 513 inoculated there were eight cases with three deaths, the proportion of deaths to cases being 37.5 per cent. The incidence of attack among the not inoculated was 6.2 per cent., and of deaths 5.2 per cent., while among the inoculated the incidence of attack was 1.6 per cent., and of deaths 0.6 per cent. So that among the inoculated



II. B.

II. B.—Inoculation on a large scale. Percentage of plague deaths to population. The shaded portions of the columns represent the percentage of deaths among the non-inoculated. The black portions represent the percentage of deaths among the same number of inoculated.

the percentage of saving in cases was 74.8 and in deaths 90.2, as compared with the non-inoculated.

Considering the observations as a whole in the different places recorded the results show that the non-inoculated part of the population had between 4.3 and 34.9 per cent. of cases, and between 0.8 and 27.9 per cent. of deaths, with a proportion of deaths to cases varying between 60.1 and 96.3 per cent., while the inoculated part of the population had been

0.4 and 4.8 per cent. of cases and between 0 and 2.5 per cent. of deaths, with a proportion of deaths to cases varying between 0 and 53.1 per cent. The number of cases among those inoculated was reduced by between 52.2 and 94 per cent., and the number of deaths between 75.7 and 100 per cent., as compared to the incidence of attacks and deaths among the non-inoculated inhabitants of the same localities.

The following diagrams refer to the observations on large communities, and they are constructed on the same principle as those relating to the smaller communities.

Diagram II. B illustrates epidemics of different degrees of severity and the relative incidence of the disease among the non-inoculated and the inoculated. The whole column represents 100 inhabitants inoculated or non-inoculated, the shaded portion shows the percentage of deaths among the non-inoculated, and among the inoculated. The incidence of deaths in the non-inoculated population varied between 0.8 and 27.9 per cent., whereas among the inoculated it varied between 0 and 2.5 per cent.

Diagram II. E shows the saving in the number of deaths among the inoculated compared to the non-inoculated. Each column represents 100 deaths which occurred among the non-inoculated population. The shaded portion of the column represents the number of deaths which occurred in an equal number of the inoculated population. The remaining blank portion of the column shows the percentage of deaths averted by inoculation. The saving in the number of deaths effected by the inoculations varies between 75.7 and 100 per cent.

These diagrams bring out in a very clear manner the great value of the inoculation. Stated generally, the average reduction amounts to three times fewer attacks among the inoculated, and should the inoculated take plague the chances of death are reduced at least twice. Accordingly, the chances of escape from death are six to one in favour of the inoculated compared to the non-inoculated. In many cases they are at least ten to one in favour of the inoculated—that is, out of 1,000,000 deaths among a non-inoculated popu-

lation, if that population had been inoculated and exposed to the same infection, 900,000 lives would have been saved.

There are numerous other observations that might be quoted showing the value of Haffkine's prophylactic as a protective against plague. I shall content myself, however, by giving two further examples, one recorded by Dr. J. A. Turner, health officer of Bombay, and the other by Lieutenant-Colonel J. A. Cunningham, I.M.S. The first relates to the municipal employees under Dr. Turner; 7,182 were inoculated, and 418 were not inoculated. Out of the 7,182 inoculated there were fourteen attacked with plague, and thirteen died, being a percentage of 0·19 of attacks and 0·18 of deaths, whereas among the 418 not inoculated there were twenty-eight attacked and twenty-six deaths, equal to a percentage of 6·7 attacks and 6·2 deaths. If the inoculated had suffered to the same extent as the non-inoculated they would have furnished 481 attacks with 446 deaths, instead of fourteen and thirteen respectively. The second refers to a small plague-stricken village in the Umballa district of the Punjab, where Lieutenant-Colonel Cunningham inoculated nearly half the population. Lieutenant-Colonel Cunningham describes the circumstances connected with the inoculations as follows:—

“The village is Chamaru, about nine miles from Umballa city, situated in Thana Ganour in the Patiala State, the population of which was 783 souls. Narain Singh, a Lambardar of the village, brought in batches to the civil hospital, Umballa, between March 21st and 27th, 1907, 312 people, comprising men, women and children of all classes, and these were inoculated with plague prophylactic serum by Captain Ross, I.M.S., assistant plague medical officer. The Lambardar, to whom great praise is due, took this action because rats were dying of plague in the village. On March 22nd, the day following the first batch of inoculations, cases of plague were observed amongst the people of the village, and between this date and May 14th sixty-four people contracted the disease, thirty-eight dying.

“We can now compare the results (which I had

carefully verified on the spot by a medical officer) between the 312 inoculated people and the 471 non-inoculated similarly situated in all respects, except for the difference in inoculation. Out of 312 inoculated, thirteen contracted plague, and four died, whilst amongst 471 non-inoculated people fifty-one got plague and thirty-four died. The percentage works out for inoculated, attacks 4.13 per cent. and deaths 1.25 per cent.; whereas for uninoculated the figures are: attacks 10.8 per cent. and deaths 7.2 per cent.

“ For comparison I had the results ascertained in another village, Rampur, population 484, situated two miles from Chamaru in the Patiala State, where no inoculation had taken place. Here there were seventy-four attacks and thirty-two deaths, the disease occurring simultaneously with that at Chamaru between March 14th and May 14th; the percentages here are: attacks about 15.2 per cent. and deaths 6.6 per cent. of the population. Of the four who died in Chamaru amongst the inoculated two of them showed signs of the disease the day following the inoculation, and in their case it is safe to assume that their fate was sealed by previous infection before the protective effect of the inoculation came into operation.

“ It is, I think, a fair assumption that the inoculation of these 312 people saved the lives of nineteen and saved twenty-one others from an attack of a very serious disease. If we could conceive a relative amount of immunity from death and plague throughout the Punjab, what a difference it would make in the experience of thousands of families, and in the population of the province. Even if this Umballa district, with its population of about 763,250 had been thoroughly inoculated, these figures show that about 20,000 of the 26,551 deaths from plague this season might have been averted. This and previous experience would justify the revival of an extensive inoculation campaign throughout the country.”

DURATION OF IMMUNITY.

Observations in Hubli, Dharwar and Gadag, three towns in the Southern Mahratta country where a large number of inoculations were done in 1898, tend

to show that the effects lasted for several years (weekly reports of collector of Dharwar). The annual reports of the Parsee community in Bombay and the general report issued by them in 1902 seem to indicate that the effect of the inoculations lasted four or five years, though gradually it diminishes. Certain indications in a similar direction were obtained in the Punjab in observations made in twenty villages.

THE MULKOWAL ACCIDENT.

The inoculations have been going on for ten years in India, and several millions of people have undergone the operation. In these ten years there has been only one serious accident, and this was due to a departure from the technique or rules prescribed by the laboratory when opening a bottle of prophylactic in a village in the Punjab in 1902, in other words, to a faulty application of the prophylactic, and not to a fault in its preparation. This accident is an important event in the history of plague operations, and as the inquiry into it is of great scientific interest it is desirable briefly to record the salient facts connected with it. These facts have been gathered by a special commission of inquiry in India. Briefly, they are that the bottle was one of five filled from the same cultivation flask, and four were used without any ill-effects, proving that the laboratory flask was not contaminated; further, the bottle had been issued from the laboratory twenty-six days before being opened, and when opened had no smell. This absence of smell is proof that no culture, even of a few days old, of the tetanus bacillus was present. A number of other facts confirm this conclusion. Thus the period of incubation and the duration of the disease were prolonged, which would not have been the case with an injection of a ready-made culture and toxin. It was found that the Mulkowal tetanus bacillus when experimentally introduced into a bottle of water agar prophylactic for a few days produced a very rich and extraordinarily toxic culture; $1\frac{1}{2}$ cc. of this mixture of toxins and microbes would represent an infection such as never occurs in nature. The disease should therefore have been of the most fulminating

character ever observed clinically; whereas, on the contrary, it was of an average character with a relatively long incubation period and duration of the disease. The syringe, moreover, with which the injections were made did not convey tetanus to those inoculated from other bottles, which would have been the case if it had been infected with a rich culture of tetanus, notwithstanding a soakage for a few minutes in a carbolic solution of 1 in 20. The dregs of the bottle showed some aerobic microbes, and only a poor and weak culture of tetanus such as would develop under aerobic conditions, subsequently to the emptying of the bottle. The actual contamination of the bottle was rendered possible by the local authorities having abolished the laboratory instructions of sterilisation by heat and having substituted for them momentary dipping in carbolic acid. In the opening of the bottle the cork and neck were not sterilised by passing through the flame, and for withdrawing the cork soiled forceps were used which had fallen to the ground and were applied to the mouth of the bottle without sterilisation. The fact that no accident occurred while the proper technique was unaltered proves the high degree of safety with which operations on a large scale can be carried out in India.

LECTURE IV.

Delivered on June 27, 1907.

NO SPECIFIC TREATMENT FOR PLAGUE.

MR. PRESIDENT AND FELLOWS.—I shall not touch on the specific treatment of plague. Great expectations were raised on the introduction of Yersin's serum, but they have not been realised, and a serum has yet to be discovered which, while being germicidal in its action, also possesses antitoxic properties. The researches of the late Dr. Allan Macfadyen were directed to the preparation of a serum with these double properties, but his untimely death at a moment when he appeared to be on the verge of success has postponed an early solution of this problem, though the researches have, I think, shown the direction in which the solution lies.

CONSIDERATIONS RELATING TO PREVENTIVE MEASURES IN THE PAST.

From the historical part of these lectures it will have been gathered that the discovery of a prophylactic by Haffkine gives the only measure of defence against plague that has not been employed more or less by some authorities in the older epidemics. Isolation of the sick, evacuation of the infected house, and segregation of contacts, disinfection, destruction of animals and *cordons sanitaires* were employed. Quarantine of ships from infected ports, and purification of merchandise according to the methods known at the time were also put into force. How frequently they were successful there are no means of knowing, but the numerous epidemics with the large mortality recorded are evidences of their failure in a large number of instances. The failure was caused mainly by the uncertainty of diagnosis with its attendant

delays until the epidemic had become established and by the employment of an improvised and untrained service to deal with the disease. Deficiencies in organisation were attempted to be made up for by stringency and severity in rules. Thus at Windsor in the time of Queen Elizabeth, in order to protect the Court, a gallows was erected in the market place to hang everyone who came from London or brought wares from there during the epidemic of plague. In 1585 three gibbets were erected in different parts of Aberdeen "in case any infected person arrive or repair by sea or land to this burgh, or in case any indweller of this burgh receive, house or harbour, or give meat or drink to the infected person or persons the man be hangit and the woman drownit." These are echoes of the stringent measures taken by Count Barnabo in the fourteenth century to prevent people from plague-stricken places entering his territories. In Europe when plague prevailed the services of medical men as advisers and attendants on the sick were understood and taken full advantage of, but their services as sanitarians, directing and controlling with special knowledge and machinery the fight against epidemic disease, were not known. The idea is a product of the Victorian era, and it is not to be forgotten that the impetus for modern preventive work in medicine both for Europe and for India owes its source to England. In India the idea has developed more slowly than in Europe, the conditions there being less favourable to rapid progress. It began in the appointment of sanitary commissioners to provinces, a sanitary commissioner for the Government of India, and health officers to large towns such as Calcutta and Bombay, and the making of the civil surgeons *ex-officio* health officers of the station and district to which they were attached.

The Indian Medical Service, which does magnificent work in India, is very limited in numbers, and being spread over the whole of India has a very scattered distribution. Duties military and civil have been assigned to it, and among the civil are attendance on Government officials, on the civil population, on the prisoners in the jails, on the inmates of the asylums,

and on the patients in the local hospitals. Besides these duties the civil surgeon is expected to deal with vaccination and sanitation. There is also a small group of officers attached to the laboratories that are springing up in India. The Indian Medical Service being small and not having been increased proportionately to the increased duties which have been laid upon it by the authorities, forgetful of the incident of the last straw on the camel's back, it is impossible, even if its strength were doubled and devoted wholly to preventive medicine, for such an establishment to deal with plague without being supplemented by a large and well-trained native service. There are 145 small towns in the Punjab alone.

It has been recognised for many years past by medical men in India who have paid attention to the subject that the sanitary organisation does not meet the wants of India and that great and fundamental changes are needed. The subject was publicly discussed on a paper read by me at the first medical congress in India held at Calcutta in 1894, *i.e.*, nearly thirteen years ago, and as a result of that discussion a deputation from the congress, headed by Surgeon-General R. Harvey, late director of the Indian Medical Service, who was a Fellow of this College, waited on the Government of India and pointed out the urgency and importance of providing a special sanitary service for India which should consist mainly of medical persons specially trained at the medical colleges of India in preventive medicine and which would open up an honourable and useful career in Government service for a number of the more ambitious and well-educated medical students attending the colleges in India. It was felt that just as there are a police service and a medical service there should be a separate and distinct sanitary service which should have its own budget. This was nearly two years before plague reached India, and the recommendation was based on the powerlessness of the system then existing to deal with preventable disease in India. The diseases then in view were cholera, malarial fever and kala-azar. The appearance of plague in India accentuated the necessity for such a service, and to its absence and the

employment of improvised agencies consisting mostly of laymen may be partly ascribed a portion of the hostile attitude of the people and of the failure to deal with the disease.

In Europe in former times, in addition to the absence of any specially organised staff to deal with plague and the difficulty relating to diagnosis, there was also, as there always must be in every large epidemic, the difficulty of providing sufficient hospital accommodation for the sick and camps for those who had been in contact with the sick. Under stress of circumstances the fact which had been recognised at an earlier period that it was dangerous to shut up the sick with the healthy in an infected house was lost sight of, and the practice came into vogue during the great epidemic in London to quarantine the house and household in an infected house. It was against this practice that in 1720 Dr. Richard Mead, a distinguished Fellow of this College, wrote when Europe had become alarmed by the severe epidemic of plague in Marseilles in that year. Dr. Mead advocated a return to the system which had been practised in Venice and Scotland since the sixteenth century—viz., the evacuation of infected houses, the sick being removed to hospital and the sound to special airy buildings outside the town. He recognised, however, that a time might come when the epidemic had increased to such an extent that this policy was impossible to carry out, and that then, beyond fumigation of the house and attention to personal health, there was little to be done except forbidding convalescents to leave the house until a certain time had elapsed. To prevent infection being carried from an infected town to a healthy one he advocated the abolition of *cordons sanitaires* which the Marseilles authorities had adopted and which, owing to the food supply being thus cut off, added greatly to the miseries of the population without any corresponding advantages. He proposed the substitution of a passport system after the person who came from the infected town had undergone quarantine or observation for a certain time and disinfection of goods.

MEASURES SOLELY DIRECTED AGAINST INFECTED
PERSONS AND THINGS WILL NOT CHECK AN EPIDEMIC.

Writing against a system which favoured the spread of the disease from the sick to the healthy, Dr. Mead's proposals dealt only with infected persons and infected goods, and did not include Fiocchetto's recommendation that arsenic should be prepared for the rats after the cats, dogs, fowls and pigeons in an infected house were killed. It is obvious that if the lower animals, and particularly rats, suffer from plague and spread the infection to men, measures directed solely to infected persons and infected goods will not stay an epidemic. The very slow recognition of this fact has contributed more than any other cause to the spread of plague once the infection has been imported into a new locality and has become established there.

For many years before plague appeared in India my thoughts had been directed to the possibility of preventing disease in man by dealing with the allied disease in animals before it reached man. It was partly with this view that I had carried on for years researches as to the relationship of small-pox in man with certain diseases in animals. When several cases of plague occurred in Calcutta and rats were dying in several houses in a particular quarter of the town an opportunity came in an unexpected manner of putting this view into practice, for it had been observed in Bombay that the mortality of rats preceded plague mortality in man. Steps were accordingly taken to have the rats destroyed in the few houses in which they were observed to be dying with the object of preventing the spread of the disease. The measure met with success and the sickness and mortality among rats was arrested. I left Calcutta in 1897, and it was not until April of 1898 that rats were found again to be dying in the sheds connected with the shipping and with the railways, evidently a fresh importation; and with the mortality came the first outbreak of plague in Calcutta.

In Cape Town, after much delay and experimenting, large quantities of Danysz's virus were used with the object of destroying rats in infected quarters, and it is

remarkable that no recrudescence of plague has ever occurred in this town. In Hong Kong a similar policy of dealing with the dissemination of the disease by rats was carried out, and with comparative success notwithstanding continual importation of the disease from China. Even this measure has its limits, and unless directed with intelligence it is not likely to be successful. It is impossible to destroy all rats in a country, and any measure having in view this object is destined to fail. General destruction of rats is good in itself, and if the inhabitants of a town or village can be induced to join in a general campaign against rats it is a matter for congratulation. The main point, however, is to deal with the infected rats, and for this it is necessary to provide an agency to ascertain where they are and to concentrate energy on infected localities.

PREVENTIVE MEASURES ADOPTED IN INDIA.

With reference to the plague in India the fullest recognition and credit must be accorded to the Government of India for its energetic efforts to prevent the spread of the disease with the agency at its disposal. There can be no question regarding the anxious and strenuous efforts at first made to check and control the disease. The Government of India did its utmost to encourage the Government of Bombay to pursue an active policy in combating the plague, and Bombay did its best. Very large sums were spent for this purpose, amounting to at least £500,000 sterling from 1897 to 1900, and another £300,000 for the protection of the other provinces. But the measures were based, with few exceptions, on the view that plague is disseminated wholly by infected persons and infected clothing.

The failure which followed these measures in a country where the sanitary organisation was small and ineffective and where the habits and dwellings of the people favoured the spread of the disease was facilitated by other circumstances. These were the apathetic attitude of the people; the suspicions and alarms aroused by inspection of huts and houses; the opposition, sometimes merging into open hostility, to

the removal of patients from their houses ; and then, as the disease increased, the panic and flight that followed, with the scattering of the infection far and wide. The difficulties thus met with were immense, and a time arrived when it appeared to the authorities that the continuance of active measures for the prevention of the disease was not only hopeless but would raise trouble by exciting generally the hostility of the usually docile and peaceful inhabitants. A general relaxation of measures was accordingly encouraged and the adoption of plague measures was left to the option of the people themselves. In thus avoiding Scylla the authorities do not appear to have been aware of Charybdis. The plague, unchecked, and taking no heed of politics, has gradually shot ahead. Year after year it is gaining ground, and the mortality is now producing just those results which were feared would arise from a policy of activity. The disorders and excitability of the inhabitants of the Punjab have come to most people as a shock and a surprise, but they are what history teaches to be inevitable where whole families are swept away and where the people of a country are dying in immense numbers.

The result of a relaxation of efforts proved in the case of the Punjab most disastrous, and this has been the case also in other parts of India. For instance, in Berar, a province of nearly 3,000,000 of people, plague was kept well under control for six years. There was no quarantine, but notification and surveillance of people coming from infected villages to healthy places and the immediate adoption of preventive measures when a case of plague occurred, consisting mostly of evacuation of the infected house and camping out on the outskirts of the village or town. The policy met with remarkable success, notwithstanding constant importation of disease from the Bombay Presidency, Central Provinces, and Hyderabad State, and it was accepted by the people in good spirit so long as the system was believed in by the authorities. But latterly the measures were considered irksome, and accordingly they were relaxed. The next season the disease began to spread unchecked, and Khamgaon, with a population of 26,000, lost 5,000 of its inhabitants

in twelve months, and by the end of 1903 and the beginning of 1904 nearly the whole of the province of Bērar was infected. In many of the villages the villagers adopted on their own initiative precautions—*i.e.*, vacating their village and camping out at once on the first appearance of a case of plague, or of dead rats, and so escaped an epidemic, while in other villages the villagers were too ignorant or too lazy to take the initiative and adopt precautions and camp out on the first appearance of plague. These almost invariably suffered severely.

There were practically no precautions in force in the city of Nagpur against plague when the second epidemic of plague broke out there in 1903-4, and in five months, from November to March, there was a mortality of 15,000 in a population of 130,000. Many of the inhabitants took the initiative, vacating the city and camping out, and they escaped, the mortality being among those who remained in the city and who did not vacate their houses.

During the whole ten years one Presidency stands out conspicuously as having steadfastly pursued an active policy and of not leaving preventive measures to the option of the people, and this is Madras. The local Government placed full reliance on its experienced sanitary commissioner, and its confidence has been amply justified. Under the strong and able direction and administration of Colonel King, I.M.S., assisted with very inferior material as a staff, the plague has been kept under control, notwithstanding the fact that large numbers of infected persons are constantly passing into the Presidency from the neighbouring States.

IS IT POSSIBLE TO DEAL WITH PLAGUE AS IT NOW EXISTS IN INDIA?

Seeing that plague has reached the proportions it has now attained in India the question arises: Are there any measures likely to be useful in checking the epidemic which, while effective against the disease, are applicable to Hindus and Mahomedans and their mode of life? The answer is Yes, but in considering this question the sanitary condition of India and the

habits, prejudices and religious scruples of the people have to be recognised. The sanitary conditions of India, however deplorable they are, have to be taken as they exist. They are similar to those in Europe in the fifteenth century. It is not possible when an epidemic prevails to transform a town or a country into a condition which will supply it with light and well-ventilated houses and which will render it free from rats, fleas and other agents which play a part in the spread of the disease. Measures which may be desirable but which are impossible have to be distinguished from those that are possible. Under the impossible may be grouped any attempt suddenly to change the thoughts and habits of the people or the condition of their dwellings, or their dislike and hostility to wholesale removal of their sick to hospitals, or any measures based on the supposition that the communities in India can defend themselves against plague without the intervention of the Government.

It has been seriously advocated as a justification of the removal of all plague restrictions that the people, seeing the havoc that plague causes, would be willing to adopt for their own preservation European methods. The havoc has come, but not the change in thought or habits of the people. Next comes the advocacy of rebuilding the huts and houses in the infected villages and towns of India, because it has been observed that the incidence was greater in dark, badly ventilated and rat-ridden mud huts than in others, and particularly when they were grouped together in such a manner as to form a common tenement for large numbers of families. The scheme is a good one, which will be supported in principle by all sanitarians, but it is obvious that on a large scale the cost is prohibitive, and even if the money were forthcoming, could only be brought about after the lapse of very many years. In the meantime the people are dying.

The reluctance to be removed to hospital for purposes of segregation is a general one in every country, but it is accentuated in the East by the fact that in consequence of the great mortality from plague very few patients taken to the hospital return to their homes. It is necessary to consider the dislike to removal to

hospital from the standpoint of the patient and the patient's friends. I remember the difficulty as a rule encountered in getting either Hindu or Mahomedan to be removed to hospital when suffering from small-pox, which is not nearly so fatal a disease as plague. The compromise which had often to be made was to vaccinate every one in the house, and as far as possible in the adjoining houses, leaving the patient to be treated at home, and after death or recovery of the patient the disinfection of the house. A similar procedure is feasible in plague, except, as I shall show afterwards, the house should be disinfected at once. The impossibility of destroying during an epidemic all rats and fleas in a town or province has already been mentioned, and measures have to be devised to concentrate the destruction where it will be most useful; liquid chemicals, except, perhaps, in the case of latrines and also for washing one's hands, are valueless and a waste of money. Possibly an exception may have to be made to this statement regarding pesterine, a preparation of petroleum employed by Dr. J. A. Turner, the health officer of Bombay, and which he has found useful for the destruction of fleas in rooms.

IT IS IMPOSSIBLE FOR THE PEOPLE THEMSELVES ON
THEIR OWN INITIATIVE TO COMBAT PLAGUE.

Moreover, it is a fundamental point in any preventive measures in India to recognise the fact that it is impossible for the people themselves on their own initiative to defend themselves against the ravages of plague. One might as reasonably expect each village and town on its own initiative to defend itself against a powerful invading army. With the exception of a few large towns, such as Bombay and Calcutta, the general conditions prevailing in India and the relations of the Government to the people, which are of a paternal and patriarchal character, are opposed to any initiation or carrying out of measures by the people themselves without direction, supervision, and control by the Government. In 1902 the Gujrat district inhabited by Mahomedan agriculturists was seriously affected with plague. The Deputy Commissioner writes: "As a rule the people were extraordinarily

patient while the disease was epidemic in the village. their attitude was entirely that of quiescence. They were willing to take almost any steps they were advised to take so long as someone in authority was present to see it carried out, but if no one was there to see it carried out they let things go as they were before, and did nothing." This may be stated to be the general attitude of the peasants and poorer people in India. For centuries the Sirkar or Government has been looked up to for guidance, and to be told to rely on themselves or any one else besides the Sirkar is not understood.

In 1903 Mr. Maynard, a Deputy Commissioner, in his report on plague operations in the Punjab says: "The measures authorised by the Government are now in some respects behind rather than in advance of what general opinion would approve. It must be realised that the people cannot altogether protect themselves. A community that is not completely organised for self-government hardly knows what it wants, and certainly cannot enforce its will without external help. It is not fair that it should be at the mercy of selfish or reckless individuals."

The resolution of March 9th, 1904, of the Government of the Punjab points out the unfriendly attitude of the inhabitants of infected villages as among the reasons for leaving measures to the people themselves. With reference to evacuation of infected houses it says: "It is by adopting this measure that the people can help themselves best. They must not, however, look to Government for assistance and establishment. It is out of the question to provide huts or extra police." And on the subject of killing rats it goes on to say: "It has now been decided that it is undesirable to incur any further expenditure on further experiments." This policy was reversed in April, 1907, in the adjoining province of the United Provinces when it was announced in the Legislative Council that the Government had determined to depart from the old policy and to provide shelters for the plague-stricken people who evacuate their homes, £2,000 being devoted to that purpose, and a special plague committee being

appointed to advise as to the methods for fighting the disease and spending the sum mentioned.

It may be taken as an axiom that without a specially trained agency to direct and control the plague measures the essentials in regard to the prevention of the disease are forgotten or misapplied, and often useless measures are adopted. Without this agency it is a matter of the blind leading the blind. It is pitiable to read some of the suggestions which are made to deal with plague, and which are accepted and carried out in good faith as being likely to check the epidemic. Here an inspector is added to the conservancy staff, there it is a few bheesties or water-carriers, and elsewhere a native surgeon. They are all doubtless useful in their way, but as regards influencing the plague the money spent on them is thrown away. Similarly, when I was in Poona last year I learnt from the health officer that a sanitary engineer had visited the town with the object of drawing up a drainage scheme, which was an excellent thing in itself, and which would cost much money, but it would have no effect on plague, which is the most serious illness from which Poona is suffering.

THE STATE OF POONA IN SEPTEMBER, 1906.

I consider the keynote of success to the prevention of plague is the provision of money and machinery and of a special plague organisation to direct, to supervise, and, if necessary, to carry out the requisite measures. With such a trained organisation, having yearly conferences to compare notes between the heads of departments, it would be possible to sustain and to carry out a settled policy, modified only by scientific research and experience. This is what is needed for India, and I shall illustrate the necessity for it by an instance which recently came under my observation when I was in India in September, 1906. At that time plague prevailed in Poona, a town of not more than 120,000 inhabitants. At the last census it numbered 110,000 persons. The town had already in its previous epidemics lost over 30,000 of its inhabitants. This fresh epidemic began with one death from plague in June, followed by 107 deaths in July, 1,166

deaths in August, and 1,173 deaths in the first thirteen days of September. On the day I inspected the registers 90 deaths from plague had occurred before noon. By the time this epidemic was over another 8,000 deaths were added, bringing up the total of all the epidemics to at least 40,000 deaths.

Under the guidance of Dr. Satpute, the municipal health officer, I visited the plague-stricken quarters of the town, and I shall never forget the painful impression produced on my mind by the heartrending scenes of distress, despair, and desolation which met me on every side. The town had the appearance of a deserted city. The streets were silent; some of them had scarcely an inhabitant visible in them; the only sounds which occasionally broke the silence as we passed through street after street were the noise and clang of the funeral processions and the wail and cries of the mourners at houses in which a death had recently occurred. In whole streets the shops and houses were closed, and in those quarters where shops were open they were served by men who only remained in them during the day, and left the city for the night. I visited house after house where deaths from plague were being treated by one or other of the two hospital assistants under the health officer. The patients lay in rooms and passages which were often so dark that it was with difficulty they could be seen. In the house where plague first broke out in 1906 the owner had lost his seven sons during the seven epidemics from which Poona has suffered. Similar tragedies belonged to other houses. The seven epidemics have impoverished the municipality, have destroyed an enormous number of people, have brought ruin and beggary to many families, and have increased the price and scarcity of labour. Falling on the adult population, the labourers have been chiefly affected. The ravages of the plague have, however, not confined themselves to these classes, for the Brahmins have also suffered heavily. Large numbers of women and girls in all classes have been left husbandless, and young girls betrothed to young men have been made widows, with no possibility of remarriage, but with all the drawbacks before them of an Indian widow's life.

The devastation produced by plague is not a mere question of so many deaths, but the sickness and suffering, the despair and the losses, and the evils entailed thereby engender other evils and a discontent which it is difficult for any Government to meet, however anxious it may be for the welfare of its subjects.

I shall now pass on to the measures which I found in force to deal with this great epidemic. The staff consisted of Dr. Satpute and three hospital assistants. One of these hospital assistants was employed in disinfecting houses so far as possible, and the other two in treating patients at their own homes. Good work had been done so far as such a staff was able to do it, but it was a microscopic staff attempting a herculean work: 1,200 people had been inoculated since the middle of July, *i.e.*, in the course of two months. The Government granted 8 annas to all the servants who were inoculated, and the municipality 4 annas to others. Some 2,000 persons had gone out to the municipal health camps, which were available for those whose income was less than 16 rupees a month. Some 7,000 people had made health camps for themselves on the outskirts of the town. The rich had gone to their country houses, and the remainder of the 60,000 had taken to flight. About twenty out of every 100 patients were removed to the plague hospital. $2\frac{1}{2}$ annas daily, with medicine, milk, sago, and sugar were supplied by the municipality to the poorer patients attended by the two municipal medical officers. Four native medical men were fighting against an epidemic which had reached the proportions I have stated, and their energies were devoted mainly to tending the sick. With a trained service available Poona could have immediately had the necessary assistance to deal effectively with this epidemic.

FOR COMBATING PLAGUE IN INDIA AN ORGANISED
STAFF AND A POLICY ARE THE FIRST ESSENTIALS
REQUIRED.

Having considered what is impossible and useless to attempt in India, I now come to that which is pos-

sible. But before doing so it is necessary to look at the financial position of India, for if there are no funds available to provide money and an adequate machinery, then the only policy possible is that which has already been followed, with the results mentioned. In any circumstances, when the plague becomes a terror to everyone it is questionable whether attributing the scourge to the hand of God, as was recently done by the Under Secretary of State for India, is the best way out of the difficulty. Evidently Lord Palmerston's rebuke to those who wished to place the blame of the cholera epidemic in England on Providence was forgotten.

As regards finances, with the exception of 1896-97, when nearly £1,500,000 were spent on famine relief, and 1897-98, when over £3,250,000 were similarly spent, there have been large surpluses in the revenues of India during the last ten years. This is not due to money not being devoted to famine purposes, for in 1899-1900 over £2,000,000 were spent in this direction, and £1,000,000 have been annually devoted to famine purposes and famine insurance ever since. The figures indicate the liberal, magnificent, and statesmanlike policy carried out in India for the prevention and mitigation of the effects of famine. Hundreds of thousands of lives have in this way been saved.

A similar policy is required in regard to plague prevention, which destroys more lives even than famine. Since 1896 some £17,000,000 sterling have been spent on famine, nearly £1,500,000 on plague, and in spite of this there have been surpluses amounting in the same number of years to over £20,000,000. Of the £1,500,000 spent on plague since 1906 a little over £200,000 have been spent on the Punjab, where nearly 2,000,000 have died. During the years 1905-06, which is the last account available, the Imperial Government of India spent for the plague in the Punjab the sum of £2,423, and in Madras £34,603.

The following are the annual amounts spent by the Government on plague in the Punjab and the Madras Presidency since 1897 :—

		Punjab			Madras Presidency
		£			£
1897-98	.. ..	8,877	.. ..	.. ..	4,234
1898-99	.. ..	19,674	.. ..	.. ..	46,382
1899-1900	.. ..	11,560	.. ..	.. ..	39,319
1900-01	.. ..	21,045	.. ..	.. ..	13,880
1901-02	.. ..	34,532	.. ..	.. ..	14,592
1902-03	.. ..	51,772	.. ..	.. ..	24,591
1903-04	.. ..	28,980	.. ..	.. ..	37,277
1904-05	.. ..	19,526	.. ..	.. ..	52,128
1905-06	.. ..	2,423	.. ..	.. ..	34,603

With money available, there is no difficulty in providing a special plague organisation for plague work and for supplying it with the requisite material for carrying on an anti-plague campaign. Such a campaign must, however, be based on a well-defined, fixed, and steadfast policy, which shall be well known and readily applied. This would not debar modifications being made in the application of the measures according to local circumstances and the discoveries of science. The principles guiding such a policy would be first the discarding of measures which are inapplicable to India, and which on that account are bound to be unsuccessful; also of measures which, though useful from a health point of view, have no influence on plague; and, secondly, the steady application of measures known to be of value; for instance, the passport system, inoculation, evacuation, destruction of rats in infected localities, and the disinfection in its widest sense of infected houses. These have all been recommended and tried more or less at one time or another in several places, *i.e.*, locally; but their success depends on their adoption in every province, and on the agency and regularity and thoroughness with which they are carried out. With a special organisation provided, such measures are possible, and without it the attempt to deal with the epidemic is hopeless.

MEASURES TO PROTECT HEALTHY DISTRICTS.

Differentiation is required in the treatment of areas in which the disease is endemic and in which it is not. Healthy districts should in every circumstance be kept free from plague. This can be effected, as it has been done in the Madras Presidency, by a passport system

and surveillance and immediate action on the occurrence of a case of plague. No relaxation on any account should be allowed. This should be an Imperial policy admitting of no modifications. It is to the interest of the locality concerned and to the interests of adjoining localities which are unaffected. Examples have already been given of the alarming results following relaxation in this respect. A careful inspection of crates filled with goods from infected localities should also be arranged for in order that any dead or sick rats may be immediately discovered and disposed of in a safe manner, and the contaminated portion of the goods disinfected; for the same reason an inspection of fodder and loads of grain from infected localities is necessary. The warehouses attached to railways and docks require to be specially watched, also granaries, stables, slaughter-houses, and markets, where rats from infected localities are likely to be imported and spread infection among indigenous rats, or where contaminated goods infect healthy rats.

MEASURES IN INFECTED LOCALITIES.

With regard to infected areas the only measures on a large scale available are inoculation, evacuation, and disinfection of infected houses and destruction of rats. Of these, inoculation is by far the most powerful and effective. The feasibility of inoculation in the infected districts and houses, if a suitable agency is employed, is demonstrated by the success of the inoculation campaign undertaken in 1902 in a portion of the Punjab. The scheme as originally planned was to inoculate 7,000,000 of the people at a cost of a little over £50,000. It was a splendid conception, and if the time and planning devoted to its realisation had been more liberal and less hurried, the organisation would have been on a larger and more complete scale, and more adequate for the occasion. Half a million of people, however, were inoculated, and an investigation carried out by the Government of the Punjab showed that the mortality from plague among the inoculated was reduced to one-twelfth of that which

occurred among the non-inoculated, so that it is estimated that 13,000 lives were saved by inoculation during that season.

The Mulkowal accident which occurred at the commencement of the campaign unfortunately shook the confidence of the Government in the prophylactic supplied, and, as I have shown, the laboratory was wrongly held responsible for an accident which was actually due to defective organisation, which admitted of faulty technique in the application of the prophylactic at the time of the inoculations. The people themselves, however, appear to have understood that the tetanus was an unfortunate accident, and were not in the least deterred from availing themselves of the inoculations any more than people are deterred from railway travelling because an express train has met with an accident. This is apparent from the fact that whereas before the accident happened over 100,000 persons came forward to be inoculated, during the season subsequent to the accident nearly 400,000 were inoculated. Major S. Browning Smith, of the Indian Medical Service, who took an active part in the inoculations, describes the attitude of the villagers in this respect. When he began to give the Amritsar people an account of the Mulkowal accident they said that they had seen for themselves the good effect of the inoculations, and the sooner he stopped talking and began working the better they would be pleased. He soon finished the few doses he had with him, and he remarks: "The genuineness of their feelings was evidenced by the reproaches of those who had to go away unsatisfied, the reproaches of some of the women taking the form of an abuse which was evidently heartfelt." However, with the Government averse to continuing any sustained effort, little or no further progress was made, and in 1904, when the plague was causing enormous ravages, only 49,000 persons were inoculated in the Punjab. It is stated in the report of the Inspector-General of Civil Hospitals, who was in charge of the plague operations, that "no special measures were taken for inducing the people to submit to inoculation, and the operation was performed almost

solely in response to the spontaneous demands of the people." An attitude of this kind in a grave crisis is unjustifiable. In no country of the world can the peasant population be expected to form an opinion on the merits or utility of a scientific method, and even if its utility were appreciated by them, as appears to have been the case with the 49,000, the initiative and organisation required for providing that the full benefit of the measure shall be secured devolve upon the Government. There is no reason that Haffkine's great discovery should not again be made use of on a larger scale. If it finds favour with the Government to-day it will be in favour with the people to-morrow, but the organisation must be such that in its application in the villages there is not the slightest chance of another accident. I believe a pronouncement exonerating the laboratory would, in the circumstances in which it has been mistakenly blamed, have an excellent effect in reinstating the enthusiasm for inoculation.

There is no reason, moreover, that systematic endeavours should not be made whenever a case of plague occurs in a house to get the inmates of the house, and possibly those of the adjoining houses, to be inoculated, and if the benefits are thoroughly explained to them in their own language and tactfully, Indians, like other people, are not averse to avail themselves of anything that is likely to be to their advantage so long as they believe in the honesty of those who are dealing with them. Necessarily, one comes across exceptions who will have none of it, but these sort of people are not confined to India. Inoculation is the cheapest mode of protection. The cost of vaccines, establishment and equipment works out to be less than 6 annas per person inoculated, which is not an excessive expenditure. Owing to the original Punjab scheme being abandoned the cost was slightly over 1 rupee a head on the 500,000 inoculated, but if the numbers contemplated—viz., 7,000,000—had been inoculated it would have cost about $1\frac{1}{2}$ annas, or about $1\frac{1}{2}$ d., per head. The margin of 6 annas per head will therefore be seen to be liberal.

Evacuation of an infected locality and inoculation

promptly carried out will stop any epidemic. In Cape Town plague was becoming serious among the Kaffirs. It was decided to remove them from their dwellings, where they were crowded together under most insanitary conditions as bad as, if not worse than, any in India. In the course of a week from 7,000 to 8,000 were removed to a small village prepared for them, and all were inoculated. The epidemic ceased among them, and although after two or three days' rest in order that they should recover from the malaise caused by the inoculation they came in regularly to Cape Town and often worked in infected portions of the town, they remained free from the disease.

In an infected area the measures to be adopted are controlled to some extent by circumstances. In some localities all the measures mentioned can be brought to bear, and of course these are the best conditions for success. But if plague is in a village where there are no means of disinfecting the huts and destroying the rats during the process of disinfection, then evacuation and inoculation are the only measures that can be practised, and if inoculation is carried out the evacuation need only be as long as is necessary to allow of time for the inoculations. Exposure of the grain to the sun, boiling the infected clothes, general destruction of rats, and a general use of pesterine, as advocated by Dr. J. A. Turner, the health officer of Bombay, should also be carried out. In towns where it is possible to carry out disinfection the complicated and unsatisfactory methods belonging to the systems now in vogue should be abolished. When dealing with an epidemic I know of nothing which is more irritating to householders, rich or poor, and which contributes in a greater degree to the hostility met with in disinfecting many houses and to the fostering of surreptitious removal of infected clothing, than the fact that everything suspected has to be removed to a central station for disinfection by steam, that the furniture and house have to be sprayed and washed with disinfectants, and that the inmates of the house are turned out for nearly a fortnight before they can get back again. It is exceptional if during the several procedures some articles are not lost or spoilt. At

the end of the disinfection, even with careful work, insects will often be seen in the Tropics to survive, while the process has no effect on the rats or the rat runs. For these reasons I would abandon all disinfection of this kind and substitute a system of fumigation by a gas which shall disinfect everything *in situ*, which shall, in addition to destroying the germs of the disease, kill the fleas, bugs, other insects and rats, and which shall disinfect the rat-runs in the house.

The Clayton method of disinfection, which consists in the pumping of sulphurous acid gas with sulphuric anhydride into the house, destroys not only the plague germ but all rats, fleas, bugs and other insects in the house, and it can be applied to thatched huts with the same effect. The gas is generated by burning sulphur at a high temperature in a specially constructed portable apparatus which is brought to the front or back of the house and which is not unlike the vacuum carpet cleaners. One pipe from the apparatus conveys the sulphurous acid gas, previously cooled down to a normal temperature, into the house, and another pipe also connected with the apparatus draws the air out of the house and through the furnace. Gradually the air in the house becomes saturated with sulphurous acid gas, and it has been established that a few hours' exposure to a 2 per cent. gas in the different rooms is destructive to insects, rats and the plague germs. Not more than seven hours would be required for each operation. The advantages of this method of disinfection are that no occupant of a house need evacuate the house for more than twenty-four hours at the most, that no furniture, bedding, nor clothes require to be removed from the house, so that there is no risk of the articles being mislaid or stolen. Everything is disinfected *in situ*; the only articles that require to be removed are such foodstuffs as flour, fresh fruits, fish and meat. Rice and grain need not be removed and would be disinfected along with the other contents of the house. As rice and grain are the most common foodstuffs and the most liable to be contaminated by infection their disinfection is most important. Any discolouration of exposed metal or silk stuffs can be immediately removed by a weak solution of ammonia

without any damage whatever, and a very important fact in connection with this mode of disinfection is that even such things as become tarnished by direct exposure to the gas are unaffected when they are covered with cloths or are in closed boxes, and yet they are disinfected. The gas also has a certain penetrative power into the soil. As stated previously, the disinfection is as applicable to huts with thatched roofs as to houses, and more than one series of pipes can be attached to one machine, and blocks of houses can be disinfected with several machines in such a manner that the rats, old and young, are prevented from migrating from these blocks and so get destroyed, and the infected rat-runs are also disinfected. In the case of a plague patient being in the house and objections being raised to removal to hospital the patient can be made comfortable in a tent during the fumigation and be removed back to the house after twenty-four hours, for with the rats and insects destroyed there would be little danger of the spread of the disease. After the patient had recovered or died the house could be again disinfected.

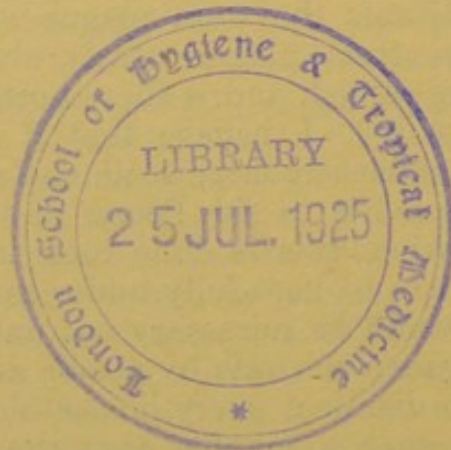
HOW TO PREVENT RECRUDESCENCE AT POONA.

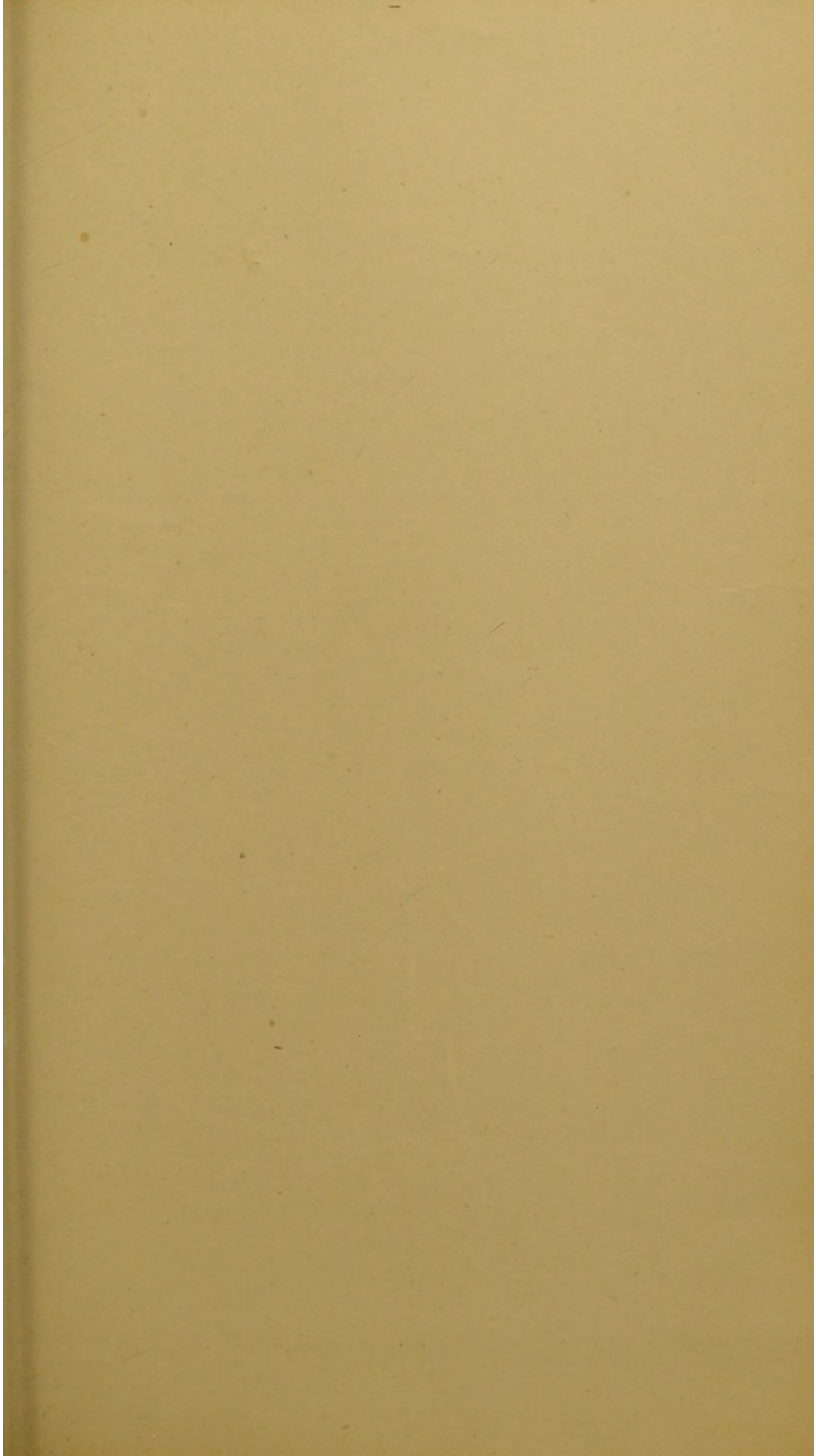
From a practical point of view it might be asked, What can be done with Poona, which has had 40,000 of its inhabitants die from plague since 1896, and which suffers from plague nearly every year? The town is being ruined, and is there nothing that can be done to save it? I believe that if measures were taken on a sufficiently large scale and on an organised plan it is possible to rid Poona of its recrudescent plague, and when this is done then imported plague might with care be kept fully under control. For this purpose it would be necessary not only to carry on a campaign against the rats by poison and by Danysz's virus, but to disinfect every house, block by block, in the town in such a manner that the rats, fleas and plague bacilli in the houses and rat-runs were destroyed. It is possible to disinfect by Clayton's machines every house in Poona in the course of six months at an approximate cost of £1 a house, exclusive of the plant. I have not been able to ascertain

exactly the number of houses in Poona, but there are certainly not more than 20,000. After the disinfection the plant, with the exception of two machines, could be used for other towns or districts. The two machines left would be sufficient, with the other precautions, to prevent the disease when imported from spreading and assuming epidemic proportions.

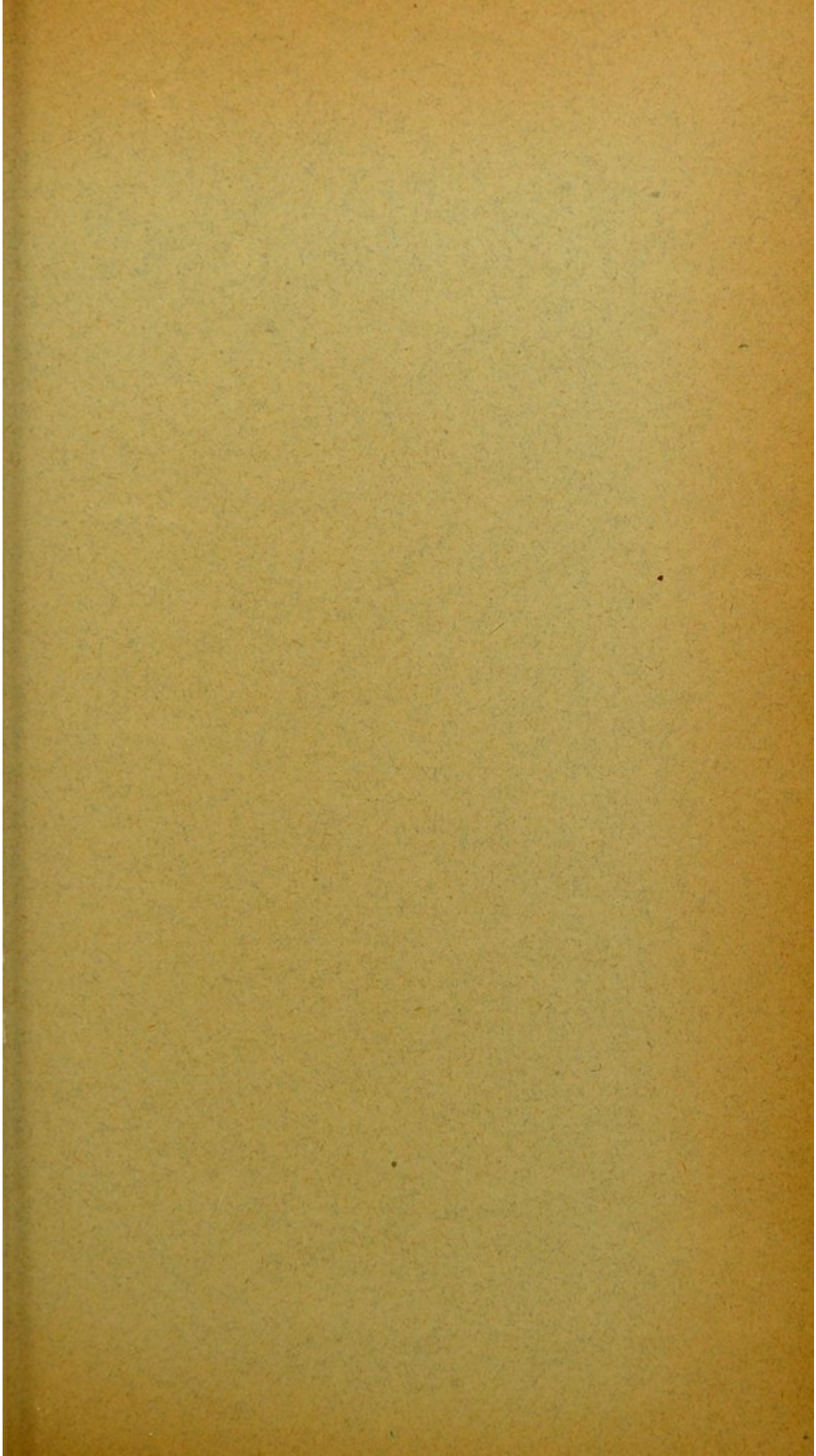
CONCLUSION.

It will be noted that my whole thesis in this lecture is based on the necessity of the formation of a special and trained plague service for the prevention and mitigation of plague in India. If this service is organised on proper lines and on a liberal basis the rest will follow. But steps must be taken for it to be done quickly if more stupendous disasters than those of the present year are not to follow and if the great danger to the people of India is to be averted.











26.

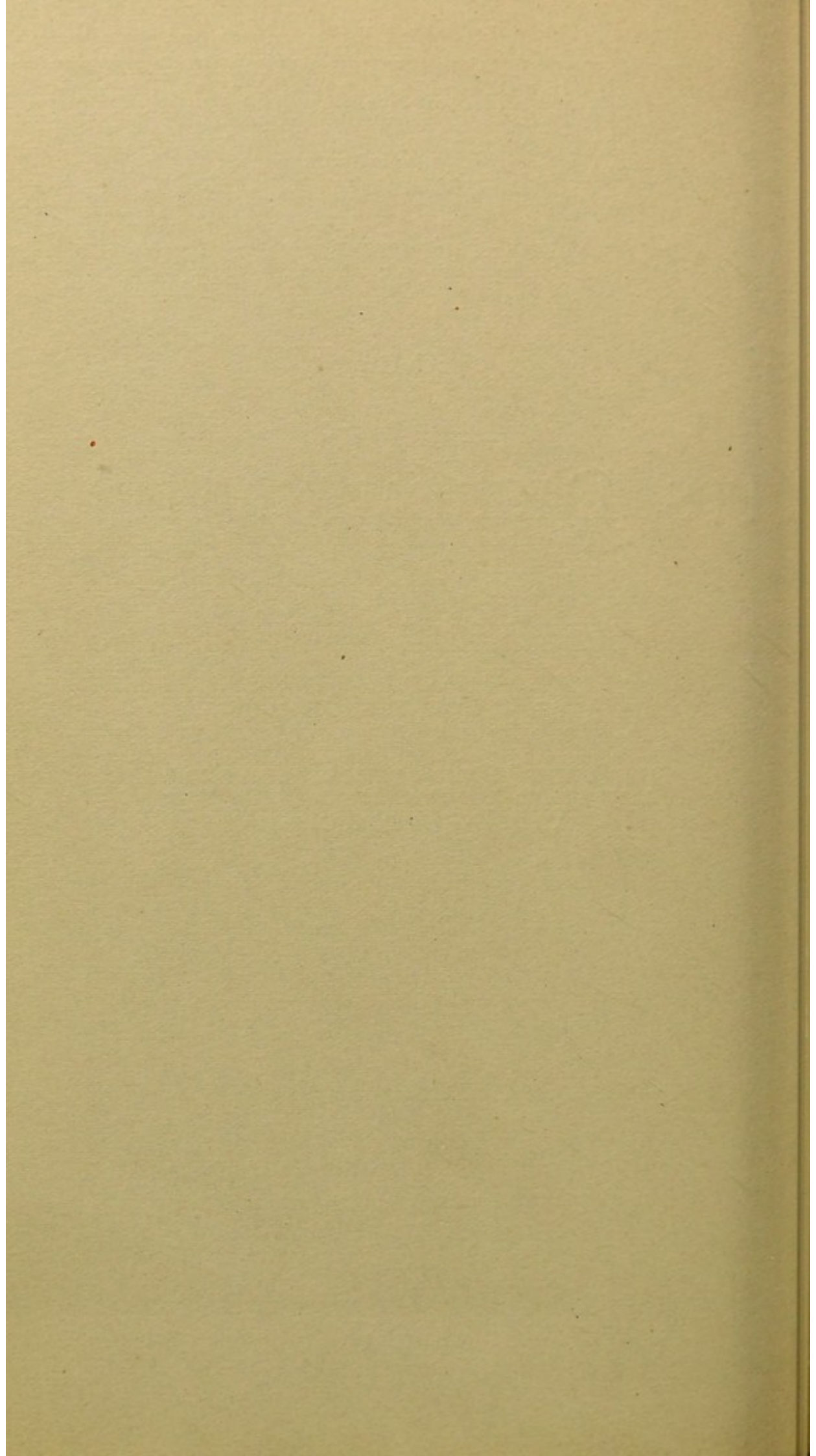
ON PLAGUE
AND
ITS DISSEMINATION.

BY

FRANK TIDSWELL, M.B.,
CH.M. (SYD.), D.P.H. (CAMB.)



SYDNEY : WILLIAM APPLGATE GULLICK, GOVERNMENT PRINTER.



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An Address delivered before the New South Wales Branch
of the British Medical Association
27 APRIL, 1900

BY

FRANK TIDSWELL, M.B.,

CH.M. (SYD.), D.P.H. (CAMB.);

Fellow of the Incorporated Society of Medical Officers of Health;
Principal Assistant Medical Officer of the Government of New South Wales;
Microbiologist to the Board of Health.

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PLATES.

1870



ON PLAGUE AND ITS DISSEMINATION.

1.—The Present Pandemic of Plague.

IN the mountain valleys of Yunnan, in south-western China, there exists an endemic centre of plague. Our knowledge of it is of comparatively recent date, but it is to the effect that plague has been prevalent there since 1860, and probably from a date earlier still.¹ When and how it first came there is quite unknown.

It is said as a rule there was little communication between Yunnan and the adjacent Chinese province of Kwang-si.² In 1892, for military purposes, certain caravans left Yunnan whilst plague was raging, and upon reaching Long-Tcheou on the Canton River, certain of the muleteers from the Yunnan villages fell sick, and died of plague. Infection of the town followed. In 1893 the disease recurred at Long-Tcheou; was conveyed down the Canton River to Naningphu, and from thence overland to the seaport in communication with it, viz., Pakhoi. This route is said to be that of nearly all the traffic from Upper Kwang-si to Pakhoi.³ In February, 1894, plague appeared at Canton, and in April at Hong Kong, to which places it may have been carried either along the Canton River, or by sea from Pakhoi. There was a recurrence at Hong Kong in 1895.

Such is the history as far as known of the manner in which plague, after centuries of comparative quiescence, broke bounds, so to speak, at the beginning of the pandemic in which we are now participating. From Canton and Hong Kong the disease subsequently spread to other eastern

places, *e.g.*, Macao, Amoy, up the China coast to the island of Formosa, the port of Inkou near Newchang, and to Moukden; to Port Arthur; to Kobe, in Japan; and quite recently to Manila. There is said to be an endemic centre in Manchuria and Mongolia, North China,⁴ not far removed from Neuchang and Moukden, but it is believed the disease came to these places not from Manchuria, but from Southern China.

The disease simultaneously extended itself in the other direction, and in 1896 appeared at Bombay. There is an endemic centre in India at Garhwal and Kumaon in the Himalayas, but this is not under suspicion as the source of the outbreak in India. The primary incidence of the plague at Bombay was at Mandvi, in a quarter near the Port, to which it is believed to have come over sea from Hong Kong. From Bombay as a centre the disease spread overland to many towns and villages—Surat, Baroda, Ahmedabad, Palanpur, Poona, Karad, Belgaum, Hubli, &c. Over sea it spread to Karachi, which also became a focus from which the disease extended into the surrounding country—Hyderabad, Kairpour, Rohri, Sukkur, Shikarpur, Jacobabad, &c. It is said, but disputed, that plague was present in Calcutta during 1896 and 1897, but this city was not officially declared infected till 1898.

Plague was reported at Bushire, Persia, in 1899. Although Kurdistan and Mesopotamia are notoriously prominent as endemic areas, the plague at Bushire is believed to have reached it from India, by way of the Persian Gulf.

Plague appeared in Russia, at the village of Anzob, near Samarcand, in 1898, and at Kolobovka, near Astrakan, in 1899.

In Arabia there is a noted endemic centre in the Asir district, Mecca and Jeddah having as evil a reputation for plague as for cholera. The disease was existent at Aden in February of the present year, probably imported over sea.

In Egypt cases of plague appeared amongst the crew of a vessel at Suez in 1898, and in 1899 (May) it broke out at Alexandria, but exactly how and from whence it reached this city is not known, opinion being divided between Jeddah and Bombay.

In the same year (1898) plague made its appearance at Tamatave, Madagascar; in Mauritius; Réunion; and at Lorenzo Marques on the East Coast of Africa. Quite recently Koch has asserted the existence of an endemic centre of plague in Uganda, Central Africa, which does not appear, however, to have played any part in the present pandemic.

Plague was prevalent at Oporto from June, 1899, to January, 1900. It broke out in the neighbourhood of the docks, and although its exact source is not known, it must, of course, have come from the East. It is believed to have been carried from Oporto to certain places in South America, having reached Santos and also Asuncion in 1899. It has appeared at Rosario and Buenos Ayres during the present year.

Near the end of last year plague became epidemic in Honolulu and New Caledonia. As you are aware, cases have been reported from Adelaide, whilst we in Sydney are not yet free from an epidemic.

From this brief, and necessarily imperfect, summary concerning the most recent extension of plague, it will be seen that the disease has once more assumed an expansive character. Even if we accept Hirsch's suggestion that those of the 6th, 14th, and 16th centuries had their origin also in China (Cathay), the present distribution exceeds in geographical extent any previous pandemic with which we are acquainted. As will be seen by the spot map before you, plague has steadily made its way south of the Equator, a fact which was observed with anxiety, and was acted upon by the Department of Public Health many months prior to the incidence of the disease on Sydney.

2.—Its Clinical Characters, Pathology, and Etiology.

The general clinical aspect presented by plague has been practically identical in all these different places, and, moreover, very much the same as it has been throughout past ages. Were Rufus to come to life again he would probably readily recognise the "*pestilentes bubones maxime letales et acuti*" of which he wrote in the third century A.D.⁵ As in the middle ages, so now plague exhibits itself as a disease in which "many die from carbuncles and boils, and botches which grow on the legs or under the arms; others from passion of the head, as if thrown into frenzy; others by vomiting blood." We see to-day "men suffer in their lungs and breathing," who "die suddenly," and on being opened are found to have their "lungs infected." We can nowadays fill in an abundance of details; we might perhaps express ourselves in more precise phraseology, but any equally terse clinical statement that we could make concerning plague would be, at best, but a variant of what the old chroniclers said of it. In the few words quoted above, for which I am indebted to Mr. Hankin's book,⁶ there are clearly instanced the bubonic, the septicæmic, and the pneumonic forms of the present day descriptions of plague.

Since general description of these principal types are to be found in most text-books, and in current medical literature, and as no doubt you are already familiar with them, it will be unnecessary to repeat them in this place. It may be mentioned, however, that whilst in many, and perhaps most, instances there is a more or less strict adherence to type, it not unfrequently happens that as the disease progresses either the type becomes mixed, as when pneumonia supervenes in a bubonic case, or there is a transition from one type to another, as from bubonic to septicæmic. In place, then, of engaging in the ordinary description of fixed clinical types, I shall perhaps more profitably spend the time at my disposal by briefly summarising

such information as I have been able to collect concerning the symptoms of most importance in the diagnosis of plague.

Prodromal Symptoms.—It is said that occasionally the actual onset is preceded by prodromal symptoms such as severe headache, vertigo, staggering gait, and absent-mindedness leading to purposeless wandering. Any such prodromata would appear to be extremely rare.

Onset.—The onset is usually quite sudden. Within a few hours the patient passes from a condition of apparently good health into serious sickness. There may be an initial rigor or fit of shivering, or in children convulsions; generally there is headache, nausea, and vomiting; weariness or aching of the body and limbs, especially pain in the lumbar region; general malaise and more or less prostration.

General Condition.—A plague patient generally, but not invariably, presents the aspect of severe sickness. Most commonly one finds him in bed, and more or less overwhelmed. In very severe cases the decubitus is dorsal from muscular weakness. Very often one leg is flexed at the hip or one arm held away from the side, indicating an effort to lessen pressure upon a bubo in the groin or axilla. The face in bad cases is pallid, but there may be a febrile flush. The expression at an early stage is one of anxiety and distress, later it is significant of resignation and apathy, and still later may become entirely vacant. The eyes are characteristically suffused and finely congested. The skin may be dry, but often there is a clammy moisture. On turning down the bedclothes one sometimes becomes conscious of a peculiar indescribable odour, which may be associated with plague, as similar odours are with typhoid or rheumatism.

Fever.—In almost every case, and in every variety, fever is one of the very earliest symptoms. The temperature rises rapidly, and is usually, but not invariably, high, 103° F. to 106° F. Some cases go through their whole course with a temperature never above 102° F., and it is said that in

rapidly fatal septicæmic cases the febrile reaction sometimes fails and the temperature may be less than 100° F.⁷ The temperature in non-fatal cases remains up from two to five days as a rule, but sometimes longer. The fall may be sudden, be followed by a recrudescence in three or four days, or may be gradual, or irregular. During early convalescence it may be subnormal.

Circulatory System.—Heart failure is specially apt to occur in plague, due, it is said, to degeneration of cardiac muscle. It may happen suddenly and prove fatal in a patient apparently not very ill or convalescing well. Beyond slight muffling of the first, the sounds are not abnormal as a rule. The pulse is generally rapid; commonly soft and compressible at first, liable to rapidly become dicrotic, intermittent, small, and thready. There is, however, considerable variability as to force, frequency, and character.

Pulmonary Symptoms.—Pneumonia in some form or other is a not uncommon concomitant of plague. It may be the dominant feature, then constituting “pneumonic plague.” Clinically this form is said not to be a typical pneumonia, but such as may be perhaps mistaken for bronchitis. It is generally a patchy broncho-pneumonia, and there may be neither marked cough nor expectoration. There may be little discoverable dulness, perhaps a few moist sounds or none at all. It is admittedly difficult of diagnosis. Generally speaking, it is to be suspected if the fever and constitutional disturbance are severe, out of all proportion to the discoverable lung trouble, and the sputum, instead of being rusty and glairy, is thin, watery, merely blood-tinged, and coughed up without much effort.⁸ The exact diagnosis is usually a question of bacteriological investigation. Plague pneumonia is not always exhibited during epidemics, and when it occurs is almost invariably fatal. Secondary pneumonia may supervene in either of the other forms of plague, and is usually early signalled by very hurried breathing. It is a serious complication, presents very much the same characters as when primary, but is not so inevitably fatal.

Alimentary System.—There is usually marked thirst. The tongue in the early stages is moist; shows a creamy white fur along the dorsum, with bright red tip and edges. Later on it becomes dry, the fur yellowish or brown, and the tip and edges a glazed, angry-looking, deep red or mahogany. These characters of the tongue are said to be preserved in every variety of plague. So far as our experience has gone it is a fairly constant symptom. Occasionally the patient complains of abdominal pain at the onset of plague, but this is generally of very brief duration. There may be persistent and violent bilious vomiting. The bowels are variable, generally constipated during the febrile period, and loose or normal later. In the few cases specially examined I have not found any tenderness on deep palpitation of abdomen, but there may be resistance or some tenderness in the iliac region above the bubo. Adequate descriptions of "intestinal" plague are not available, and as our own patients have not shown anything approaching this condition, I am unable to discuss the existence or otherwise of this special type. It is reported to have been observed at Hong Kong and at Alexandria, but was not seen at Bombay. The various Commissions do not appear to have accepted it as a special form, and Childe⁹ states that in none of his autopsies was there anything to indicate a primary infection of the gastrointestinal tract. In the septicæmic form there may be discoverable enlargement and tenderness of the liver and spleen.

Urinary System.—There are usually no special symptoms referable to the urinary system. The urine generally contains albumen in some form, occasionally bile, and in some cases blood. In many patients there is temporary retention.

Nervous System.—Many writers lay considerable stress on the disturbance of the nervous system in plague. There is said to be early loss of decision, restlessness, absent-mindedness, &c., followed by mental hebetude; the patient being unwilling or unable to answer questions, or utters only half sentences, forgetting the rest.¹⁰ The speech is said to

be specially characteristic, hesitating, broken, more or less staccato, or husky and indistinct like that of a drunken man. In the febrile stage there may be active delirium, muttering, or spasmodic noisy out-cries. In serious cases lethargy and coma ensue. Muscular spasms, stiffness of neck muscles, and paretic conditions are sometimes observed. In our own cases these various symptoms sometimes appeared early, but usually supervened after removal of the cases to hospital. They have been irregularly exhibited, though I think they have nearly all been observed at one time or another.

Buboes.—The presence of an obvious external bubo is the distinguishing characteristic of the bubonic type of plague, which, it is said, is that exhibited by 70 per cent. of patients.¹¹ It may be present from the onset, or appear within the first two days. There may be but one bubo, or, in addition to a primary bubo, secondary glandular swellings may appear in other regions during the course of the illness. Rarely there are multiple buboes from the first. The primary bubo is usually femoral. An inguinal bubo may be associated with the femoral, or may occur independently, especially in children. Not unfrequently the bubo is axillary, more rarely cervical, and exceptionally it occurs in other places, *e.g.*, in the supratrochlear or popliteal glands. The primary bubonic swelling may consist of one gland or of a group. It generally swells rapidly, but its ultimate size is very variable. The gland or glands may never become larger than marbles, but, on the other hand, may become as large or larger than a mandarin orange. The visible or palpable swelling is often several times greater owing to the presence of sanguineous effusion into the periadenitic tissue. On palpation at an early stage the swollen gland or glands will be found to be tense rather than hard, the consistence being to my mind something like that of the testicle. Later it becomes softer and doughy. Frequently the glands soon become lost in the effusion, and when this happens the whole swelling has the consistence of firm œdema, or is soft and

boggy. In most instances the swelling is very tender, sometimes exceptionally so, but on rare occasions it can be handled freely without much pain to the patient. There may or may not be an inflammatory blush visible on the skin over the swelling. The progress of the bubo is quite irregular. It may resolve or go on to suppuration, or even, it is said, to sloughing and ulceration. After opening the healing may take a normal course, or there may be discharge for several weeks. Secondary buboes are distinguished from primary in being smaller, less tender, having less infiltration round them, and being less prone to suppurate. Apart from actual buboes, palpation may reveal tenderness in glandular regions other than that of the primary bubo, and the primary bubo may itself be preceded by tenderness at its future site. Although, as already stated, buboes are the special feature of the bubonic type, glandular swellings do occur in the other varieties of plague. In the septicæmic form there is hyperplasia of the internal glands in different regions of the body, but the external glands are never, or only very rarely, affected. In any case, it is said, the special features of a plague bubo are lacking, the glands being small, not congested, and devoid of surrounding infiltration. In pneumonic plague the bronchial glands may be affected, but not, as a rule, those of other regions.

Carbuncles.—Plague carbuncles occur in a certain, usually small, percentage of cases. They may appear in any part of the body, and at any period of the acute stage of the illness. They may precede, accompany, follow, or be present in the absence of buboes. They occur as circumscribed or diffuse swellings of the subcutaneous tissue with inflammatory redness of the super-jacent skin. The size is variable. They are very apt to break down and slough, in which case the skin over them becomes discoloured and often shows a gangrenous-looking bleb or blebs containing turbid or sanious fluid. After separation of the slough the resulting irregular ulcer presents the usual appearances of granulation tissue, and gradually heals up under ordinary treatment.

Hæmorrhage.—Primary septicæmic, or cases which become septicæmic, commonly exhibit external hæmorrhage. The bleeding may take place from mucous membranes and result in epistaxis, hæmoptysis, hæmatemesis, melæna, or hæmaturia, according to site, and may be very profuse; or it may take place under the skin and result in a purpuric eruption or large effusions. These visible hæmorrhages, or “tokens,” as the old physicians called them, have their counterpart in petechial or gross bleeding in various internal organs.

Fatality.—Although plague has a very evil reputation in the matter of fatality, the present pandemic has not shown the excessive virulence exhibited by the disease in former times. We have been spared, even in China and India, the terrible experiences of the Black Death. Nevertheless, it would appear from the very incomplete figures available that the disease has not always lacked excessive virulence during the present pandemic. The general fatality in India would seem to have been 80 to 90 per cent.¹²; whilst it is officially stated that in Hong Kong in 1899 it reached to no less than 96 per cent.¹³ (1,471 cases with 1,413 deaths). On the other hand, the fatality at Alexandria seems to have been between 40 per cent. and 50 per cent., and at Oporto between 30 per cent. and 40 per cent.¹⁴ Although our own returns are not yet complete, the fatality up to the present has been lower than that at Oporto. The issue of any particular case of plague is decided, as a rule, within a few days of the onset. Death may occur in less than twenty-four hours, but most commonly on the third, fourth, or fifth day. If the patient survive a week he probably will not die of plague. The duration of the illness in patients who recover varies from a fortnight, or even less, to a month or six weeks. The patients are usually left weak and exhausted, but convalescence is commonly rapid and uninterrupted. The illness may be prolonged by continued discharge from an incised bubo, or, it is said, by intercurrent troubles, conjunctivitis and arthritis being specially mentioned in this connection.¹⁵

Pathological Changes.—Information to hand concerning the pathological basis of the symptoms of plague is not as complete as could be wished. The following summary of the more essential features recorded must be regarded as tentative, pending fuller report and the completion of our own observations on the subject:—

The *post-mortem* appearances in man are usually those of septicæmia. General vascular changes result according to circumstances in dusky congestion with œdema, rendering the organs sodden, or occasionally producing accumulations of fluid in the serous spaces; in hæmoglobin staining or actual hæmorrhage under the visceral or parietal plura or peritoneum, into the substance of the lungs, heart, liver, spleen, kidneys, cerebro-spinal nervous system and lymphatic glands; into the areolar tissue, especially that around a primary bubo, and also as petechiæ under the skin. The intravascular blood is usually but not always imperfectly coagulated.

Pathological appearances special to plague occur in the lymphatic glands, lungs, liver, and spleen.

The primary bubo begins with congestion and cellular increase, such that the lymphatic channels, as well as the reticular spaces, become crowded with leucocytes. The gland swells, and on section presents either a deep red or mottled red and white colour to the naked eye. Soon diapedesic or ruptural hæmorrhage causes obscuration of the structure of the gland, followed by necrosis, disintegration, suppuration, and even sloughing. The inflammatory changes extend to the periadenitic tissue, which is markedly hæmorrhagic, and involve perhaps also the adjacent vessels. Childe has described hæmorrhagic effusion continuous from the interior of the lymphatic gland to the lumen of the neighbouring vein.¹⁶ Glands other than the primary bubo may become congested, hyperplastic, or even contain hæmorrhages, but the changes in them are said never to approach in intensity those seen in the primary

bubo. The involvement of many glands is specially apt to occur in the septicæmic type of plague. The abdominal glands lying along the spinal column suffer with the rest, but, according to Childe and others, the mesenteric glands usually escape. In the pneumonic type only, or not even, the bronchial glands may show lesions, but when they are affected they are said to much more closely resemble a primary bubo than do the various secondary glands of other types.

The lungs are the special seat of lesion in the pneumonic type of plague. Super-added to general congestion and œdema are scattered pea to egg-sized patches of pneumonic consolidation, occasionally larger areas, and even on rare occasions as much as half a lobe is continuously inflamed. Individual patches have the general appearance of red hepatisation, with hæmorrhages, especially at the margin, and an enveloping zone of intense congestion. The middle of the patch may show necrotic changes, and if superficial, the covering pleura may be inflamed and hæmorrhagic.

The liver may or may not be swollen. It is often markedly congested, and sections may show a "nutmeg" character, or hæmorrhages. In septicæmic plague there may be profound alteration of the liver, great enlargement, pallor, cloudy swelling, hæmorrhages, and numerous scattered rounded necrotic foci, varying from the size of a pin's head to that of a pea. Histologically these areas show degenerated liver cells, leucocytes, "pus cells," and granular debris.¹⁷

The spleen is usually, but not invariably, enlarged in all the types of plague. The increase in size varies, but is said to be greatest in septicæmic cases. The consistence may remain firm, or there may be softening and disorganisation of structure. Hæmorrhages in the spleen are more common in the septicæmic and pneumonic than in the bubonic types of plague.

As regards other organs, in addition to general congestion and hæmorrhages, there may be occasional necrotic or degenerative foci, but I have not met with descriptions of changes in them specially indicative of plague.

Bacillus pestis bubonicæ (Plate 1).—We are aware, since the researches of Kitasato and Yersin, in 1894, that the various changes just referred are consequent upon infection with the specific bacillus of plague. It is not my intention to inflict upon you, in this place at all events, any detailed description of *bacillus pestis bubonicæ*. I propose to deal with, and as far as possible exhibit to you, such of its characters as are of essential importance for its bacteriological isolation and recognition, or have some special relation to its mode of dispersal.

The first practical point requiring brief consideration is the mode by which material for diagnostic purposes may be obtained. There is no difficulty in this respect when one has to deal with a dead subject, human or other. In the septicæmic, but not necessarily in the other types of plague, the bacilli may be present in the blood. They abound in the primary bubo, and in the hæmorrhagic effusion round it. They are plentiful and sometimes very numerous in the spleen and liver, and are often to be found in various other organs and lymphatic glands. In pneumonic cases, however, they may only be discoverable in the lungs, and, perhaps, the bronchial glands, though sometimes they have been found elsewhere.

The matter is not so simple when one has to deal with a living patient. When there is a bubo, one may either puncture or incise the gland itself or the skin over it, so as to allow insertion of a glass pipette. Incision is the much more reliable process, but one to which most patients naturally object. They will, as a rule, readily permit puncture with a moderately fine exploring needle. The puncture will generally, but not invariably, prove successful in securing the small quantity of fluid required. If the bubo

is small or of recent development, care must be taken to actually puncture the gland, which must be steadied whilst the small operation is being performed. Later, when periadenitic effusion has occurred this point is of less importance. The puncture must be performed with sterilised instruments and under aseptic precautions, as well in the interests of the patient as for the proper performance of the subsequent inoculation of the test animal or culture tubes. It is necessary, of course, to avoid injury to the blood-vessels. The procedure is most likely to give successful results if performed during the earlier period of inflammatory swelling. When suppuration has occurred no plague bacilli may be obtained; there may be other micro-organisms, *e.g.*, pyogenic cocci, or the pus may be sterile. From carbuncles, and especially from fluid in blebs, the bacilli are easily obtained. In the absence of both buboes and carbuncles it may not be possible to secure suitable specimens. The urine or blood may be tried, but the bacilli have appeared to me to be present only in severe cases, and most authorities are agreed that save in septicæmic cases and within twenty-four hours or so of death, there is little hope of obtaining bacilli from the blood. In pneumonic cases the bacilli are generally abundant in the sputum, either alone or in association with Fränkel-Telamon diplococci, streptococci, &c. The material obtained in any of the ways just referred to is used to make cover-glass preparations, fresh and stained, to inoculate culture tubes or test animals.

The bacillus of plague is a pleo-morphic organism. The individual elements in a preparation may be rounded like simple micrococci (Fig. 1); they may be but a little longer than broad, and then, according to circumstances, they appear either like diplococci, or short oval rods. These characters no doubt led Metschnikoff to refer to the microbe as *coccobacillus pestis*.¹⁸ Commonly, however, the elements appear in the form of well-marked rods of various lengths (Fig. 2). In young cultures they are sometimes very minute, and

measure often not more than $1\ \mu$ in length. In older cultures and smear preparations from buboes or viscera in the bacilli commonly measure from 1.5 to $3\ \mu$, and individual elements may be even longer. The ends are sometimes simply rounded, or the bacillus may taper off towards the poles and assume a long oval form. These various characters are all to be seen in the microscopical specimens exhibited.

As a rule, the bacilli are not grouped in any special way, but occur singly and irregularly distributed throughout the preparation. Occasionally two occur end to end, and if obtained from broth cultures there may be short chains of 4 to 8 or 10 elements. They do not form spores, and are not obviously motile, although they have been described as possessing flagella. Sometimes certain elements seem to be enclosed in a capsule, but attempts to stain this latter have generally failed.

The bacillus stains readily with all the ordinary simple dyes, fuchsin, gentian violet, methylene blue, but not by Gram's method. The blue is apt to give faint staining, and the violet too dense. We have found a dilute solution of fuchsin give perfectly satisfactory results. The stain is applied for about half a minute and washed off in water. No advantage was derived from the use of decolourising reagents, such as alcohol or acetic acid.

In good preparations most of the bacilli will show the characteristic bipolar staining (Fig. 3). The extent of the colouration varies. There may be merely a coloured line at the ends, with the rest of the bacillus quite clear, or there may be only a small clear space in the middle of the rod which is otherwise stained throughout. Intermediate gradations are common. This bipolar staining is not constantly exhibited in smear preparations. In some, a few bacilli showing it are only to be found after a long search, in others it is no more than suggested, and in others, again, it is not at all evident. Now and then the bacilli may show a pale

or deep uniform staining. I am, therefore, in accord with Balfour Stewart in the view that bipolar staining "cannot be relied upon for diagnosis."¹⁹

As starting media for cultures we have generally used agar, coagulated serum, or bouillon. Upon agar at 37° growth appeared usually between twenty-four to forty-eight hours in the form of numerous, small rounded, transparent, slightly raised points or droplets. Frequently they remained quite separate from one another, and showed little tendency to increase in size. If very close together they may coalesce and form a greyish confluent growth of irregular contour, with isolated colonies round the margins. In sub-culture a thin streak was formed, often with isolated colonies along the edges. As the streak grew older a mother-of-pearl iridescence was developed. When spread out and looked at through the agar, the ground-glass appearance was presented. In certain cases we have observed the two forms of colonies described by Yersin, viz., the small points already referred to, and larger greyish rounded colonies as large as pin-heads. Occasionally the whole growth was from the first confluent or cloudy. Yersin has stated that the larger clouded colonies are less virulent than the small ones.

In broth at 37° the growth begins to be visible in the course of a day or two. Small spicular or crumb-like particles were seen adherent to the sides of the tube, with a fair amount of deposit at the bottom. The broth generally remained clear, but in some cases a fine cloudiness was developed. Abel remarks that cloudiness or not depends on method of inoculation. In flasks to which a little oil was added previous to sterilisation a film and scanty crops of stalactites were obtained (not more than six or eight in any one flask), as well as a copious deposit at the bottom. I am unable to demonstrate this feature to you, as the slightest movement of the flasks causes detachment of the stalactites. We have not been successful in observing the climbing

phenomenon in broth flasks inoculated with a glass rod as described by Balfour Stewart.

Upon serum the growth was similar to that upon agar, but less abundant, although some of the tubes exhibited show a fairly good growth.

The bacillus grows fairly well in sub-culture upon various other laboratory media, but as the appearances have no special diagnostic importance, I need not describe them in this place save by way of calling attention to Haffkine's "involution forms" (Fig. 4.) If the bacillus be grown upon perfectly dry agar, or upon salt agar for two or three days, microscopical preparations then made show most extraordinary transformations; bacilli of the ordinary shape, but very much swollen, together with round, oval, spindle-shaped, and biscuit-like forms, resembling yeast-cells or algæ rather than bacilli. In very many of these metamorphosed bacilli, clear rounded spaces (vacuoles) are to be seen. If these happen to be at the edge, the appearance produced is as if a bite had been taken out of the organism. These various features are to be seen in the specimen exhibited. These involution forms are sometimes met with in the bodies of animals dead of plague. Haffkine has found them in rabbits, and Childe in human bodies, but only when autopsy was made between five to ten hours after death.

Both the Russian and German Plague Commissioners state that in the presence of serum from plague patients plague bacilli exhibit the phenomenon of agglutination, but only when the blood is taken from patients who have been ill for a week or more. In our own examinations, made in early stages of the disease, we did not observe any such agglutinating effect as would suffice for diagnostic purposes. Unfortunately, the method does not seem to be of much practical value so far as the diagnosis of plague is concerned.

The third or inoculation test depends on the pathogenicity of the bacillus. Quite apart from the incidence upon

man, outbreaks of plague in various countries have been described as preceded or accompanied by the death of various lower animals. General statements indicate that rats, mice (house, white, shrew), guinea-pigs, rabbits, pigs, horses, monkeys, cats, fowls, and lizards are susceptible; whilst pigeons, dogs, oxen, tortoises, and frogs are immune. It is difficult at the present time to decide as to whether species susceptible to inoculation are also liable to acquire the disease by natural means. There is no doubt that rats so suffer. Fatal epizootics in rats have been reported from Hong Kong, Bombay, Calcutta, Oporto, and other places as having preceded or accompanied the epidemic in man, and bacteriological examinations have shown that as in man so in the rodents, the disease was due to bacillus pestis bubonicæ. These facts have also been observed in Sydney. That mice get plague naturally is also probable, but not so definitely certain as in the case of rats. In Manchuria and Siberia the disease appears to be spread by a species of marmot (*Arctomys bobac*),⁴ and some of the Indian observers mention bandicoots. Simond records the natural incidence of the disease upon monkeys at Kunkhal, and monkeys were used experimentally by the Russian Commission in India, and by Calmette and Salimbeni in Oporto.²⁰ The Indian observers do not appear to have noticed any natural incidence on cats, although sick cats are casually mentioned by Hankin. Dr. Lorans, writing from Port Louis, Mauritius, in November, 1899, states²¹ that a number of instances of cats dying of plague have come under his notice, and that cases in human subjects have been traced to cats with open buboes in which plague bacilli have been detected. N. F. Surveyor reports²² that during the outbreak in Bombay, 1896, pigeons died of a disease identical in every way with plague. It is stated, however, that in Hong Kong no bird of any kind was affected with plague during the epidemic. Apart from an apparently romantic statement made by Boccaccio, I have not come across any decided reference to plague in pigs, nor with regard to the remaining animals mentioned in the list

given above. In Sydney there have been no reports concerning any animals except man and rats. In the laboratory our work has been done with guinea-pigs and mice.

The fact that bacillus pestis bubonicæ belongs to the "septicæmia hæmorrhagica" group of bacilli indicates the pathological changes to be expected in the lower animals.

In the rats caught in various parts of Sydney and conveyed to the laboratory for examination the lesions were similar to those seen in the specimens exhibited (Plate 3). The whole of the tissues were congested, their dusky colour being in marked contrast to the clear whites in certain parts of the normal rat. There was a marked excess of fluid, but not actual dropsy, in the serous cavities, and the viscera generally had a "soppy" appearance. One or more groups of lymphatic glands, inguino-femoral or axillary, were enlarged, and sometimes there was periadenitic œdema and hæmorrhages. In one case a mesenteric gland as large as a pea was found which contained plague bacilli in abundance, but there was no discoverable lesion of the intestine; and all other glands examined, femoral, axillary, lumbar, &c., were also full of bacilli. Generally, but not always, the lungs showed more or less pneumonia. The liver was always enlarged, often to two or three times its normal bulk; was paler than natural, and mottled with pale points. The spleen was swollen in a variable but usually very marked degree. In some of the specimens exhibited it will be seen to be $2\frac{1}{2}$ to 3 inches long, correspondingly thickened, especially at the ends. I have not detected lesions of the gastro-intestinal tract in any of the specimens examined. The suprarenal bodies were not uncommonly swollen and deep red in colour. Apart from the general congestion, the other organs did not show any special lesions. Petechial hæmorrhages were very commonly observed in the lungs, heart, liver, kidneys, and were very often conspicuous under the parietal pleura and peritoneum.

In inoculated guinea-pigs, as will be seen from the specimens (Plate 2), the lesions were generally similar to those of

the rat. There was general congestion and œdematous exudation. At the site of inoculation a marked sanguineous effusion, which also surrounded the more or less swollen lymph gland in association with that site. Rarely swelling of lymphatic glands elsewhere was observed. The lungs were generally pneumonic, sometimes not. The liver was always very much enlarged, sometimes pale and usually obviously mottled. The spleen was characteristically swollen to many times its normal size, and marked by a variable, but usually large number of whitish spots (necrotic areas). The kidneys were frequently swollen, and the suprarenals large and of a deep red colour. Hæmorrhages were common in the lungs, heart, liver, and under serous membranes. The animals died in from four to eight days after inoculation, and the lesions developed most characteristically in those animals in which death did not occur until five or six days. Up to the present the inoculations performed on guinea-pigs with material taken directly from buboes, carbuncles, viscera, &c., have been invariably fatal. It is said that with bacilli of mild virulence the animal may recover.

Diagnosis.—The foregoing statement of clinical, pathological, and bacteriological data serve to emphasise the fact that plague possesses strikingly distinctive features. In the majority of cases they are clearly exhibited, and the diagnosis can be made without difficulty. But now and then cases occur in which it is practically impossible to make a clinical diagnosis with certainty, and, exceptionally, even the most experienced observer may be in error. Cantlie confesses to having sent a man into the plague hospital whom he afterwards found to have not plague at all, but filarial fever.²³ The patient did not acquire plague as the result of his sojourn in hospital. Probably diagnosis is more likely to be at fault in the opposite direction of overlooking a case which is plague. In some patients the disease is so mild that plague is never suspected, and in others so severe that death ensues before any characteristic symptoms have developed. But what is true of plague in

this respect is also true of most other infectious diseases. We cannot pretend to diagnostic infallibility with regard to any of them.

It has to be recognised also that bacteriological diagnosis has its limitations, since it is not always possible to obtain suitable specimens for examination. If, however, the bacilli be forthcoming at all, their recognition is effected by the simplest of bacteriological operations. The work concerning the initial case or cases must be careful and complete, but afterwards, as a general thing, cover-glass preparations will suffice. For if, with the clinical appearances of plague and during its epidemic prevalence, one finds the usual bipolar staining non-motile bacilli which are decolourised by Gram's method, one may safely make a diagnosis of plague. It is even possible to be quite sure of bacilli which vary from the classical forms in certain definite particulars. But when no bacilli at all are detected, it is then not wise to infer the non-existence of plague.

Failing decisive results by microscopical examination alone, one has to depend on the slower methods of cultures or inoculation. Cultures made directly from bubo material or viscera are not always satisfactory. Sometimes the bacillus grows fairly well from the first, sometimes it forms very scanty growths which may or may not bear transference into sub-cultivation, and sometimes it entirely fails in the original tubes. Even when developing on original tubes the growth may require careful nursing before it will give decent crops. We have not observed any differences in this respect between bacilli obtained from man or lower animals. We do not consider that these irregularities have any dependence on the exact preparation and condition of the culture media, which have been carefully made according to the directions of authorities. Whilst material from one source will give growths, that from another source will not, although the tubes used were taken from the same batch in both instances. Consequently, our results lead us to say that whilst usually the cultures are positive and yield

valuable help, it occasionally happens that no growth appears, and the test fails to furnish any aid to diagnosis.

In the work performed in this Colony we have had most success with the inoculation tests, which have always yielded precise and accurate results so far as can be judged by the subsequent history of the patients on whose behalf they were performed. They were necessarily of most value to us in the beginning of the outbreak to establish the existence of plague in the first instance, and secondly to confirm and extend the results of the microscopical examinations upon which the diagnosis must rest to be useful. Increasing acquaintance with the bacillus has tended to give us more and more confidence in the simpler process, and we would now make use of inoculation only in the occasional cases where a microscopical examination fails to resolve our doubts.

3.—Its Mode of Dissemination.

“For the development of the disease and the formation of a plague centre there is always required the access of the specific virus of plague. Those plague centres extend just as far as the diffusion of the virus reaches to, but where the virus comes not, no matter how unfavourable the hygienic conditions, there the immunity from the pestilence is complete.”²⁴ In these views of Hirsch most of us would now concur, substituting the specific term *bacillus pestis bubonicæ* for the general word virus used by that author at a date long prior to the discovery of the micro-organism. The dissemination of plague, we would say, depends on the transportation of the plague microbe.

This microbe, as we have seen, is endowed with pathogenic properties, such as enable it to exhibit a very vigorous existence within the bodies of man and certain lower animals, more especially rats. Bacilli so contained could easily be carried over long distances by the movements of their hosts. But the diffusion of plague necessitates the passage

of the micro-organisms from one host to another, and its comprehension demands consideration of the means by which such a transference can be effected.

The modes of exit of the bacillus from the bodies of the infected are said to be by way of the sputum (in pneumonic cases), with discharge from buboes, &c., with hæmorrhages, and with the bowel excretions and urine. It is not quite clear from the evidence to hand whether or not the bacillus is to be found in the excretions in the absence of hæmorrhage into the respective passages, and I am not acquainted with any data concerning the length of time the bacilli remain alive after such extrusion from the body.

The behaviour of the bacilli with regard to the establishment of a growth upon the artificial media of the bacteriologist has already been considered. With the exception of Hankin's statement that the bacilli lived seven months in a sealed tube, I have no information as to how long growths will remain alive if untouched. My own cultures were too recently acquired to throw much light upon the point. By appropriate sub-cultivation the vitality of the bacillus can be maintained for long periods, but in this kind of saprophytic life the microbe is protected against the inimical agencies which would oppose its continued existence in nature.

With regard to the extracorporeal viability of the bacillus in other than laboratory media, there is very little direct information, present views on this point being based for the most part upon evidence of an inferential character.

Assuming the bacilli to be shed in the ways indicated above, one would expect to find the bed or ordinary clothing, the room or the house, the soil, or perhaps water supply, implicated in the spread of the infection. As a matter of fact, linen and clothing have always been regarded with suspicion, and numerous instances of their apparent implication have been recorded, not only in olden days, but also

during the present epidemic. For instance, in the case of a steamer from Bombay to London, and upon which two Portuguese were attacked sixteen and seventeen days respectively after arrival of the vessel in the Thames, the infection is supposed to have been carried in clothing which was unpacked only after reaching London. Collie mentions that a man having lost his wife from plague in Bombay, took her clothing and jewels to a house in a village near Hurnai. In this house both his parents died of plague soon after, neither of them having been away from the village, and finally the man himself died. The English Commissioners consider it possible that the disease may remain latent in clothing, and vague mention is made by them of the detection by one observer of the bacilli on linen. I have not seen any mention of this elsewhere, and many observers deny the carriage of plague by such articles. It may be said with considerable certainty that those who handle the assumedly infected linen most, nurses and laundresses, are not specially liable to be attacked by plague.

With regard to the infection of rooms, no special observations have come to my knowledge. Hankin asserts that the bacillus will not survive long in goods on board ship, and presumably the same results apply to similar articles on land. He has shown, for instance, that if grain be infected with a pure culture, the bacilli soon die out; extracts were not infective after fifteen days.²⁵

Occasionally one meets with accounts which appear to indicate the persistence of infection in some parts of a house. For instance, there has been reported the death of twenty coolies from plague, caught whilst demolishing a house not previously disinfected.²⁶ As such cases happen at places where plague is already prevalent, their exact significance must be open to question. Many authorities state that the infection is only present in the soil of the house, which in India is generally the floor. Yersin states that he found in the soil of an infected house, four or five centimetres below the surface, a bacillus which resembled pestis, but

was not virulent. Upon one occasion Kitasato found dust from a plague-house produce plague on inoculation, and Lawrie reports a similar experience. Presumably in these instances the occupants had recently suffered from plague. I have not seen any statement indicative of the length of time bacilli could be so detected after removal of their presumptive source. Kitasato asserted that the bacilli were easily killed by drying. It does not follow, of course, that either the soil or the dust of a house is dry, and moreover Hankin states that the results of intra-tracheal injection have led him to believe that the resistance to desiccation is by no means so slight as has been supposed. It is said also that plague may recur in the same house in successive years.

There is no doubt that plague may reappear in the same locality year after year, as witnessed by the recurrences in Hong Kong, Bombay, &c., and the persistence of the disease in endemic areas. Plague "is very often confined within a very narrow range notwithstanding free and often busy communication with the neighbourhood."²⁷ In the case reported by Francis two Indian villages were situated not 500 yards apart, and apparently under exactly the same general conditions, but whilst one was attacked at every visitation of plague, the other always escaped.²⁸ It is also noteworthy that persons who live upon the water often escape when the disease is raging close by on land. Such limitations of geographical distribution have been said to be hardly consistent with any hypothesis other than soil pollution. It may be questioned, however, whether the facts will bear this strict interpretation. Existence in the marshy banks of the Nile and in the arid desert of Arabia, in the warm soil of India, and in the frozen ground of the Himalayas and Russia, &c., imply an adaptability to circumstances on the part of the bacillus which finds no support in the known facts of its life-history. Moreover, plague epidemics exhibit a capricious incidence; places entirely escaping at one time may be severely afflicted at others. Again, plague disappears from most places after a period,

not becoming endemic like typhoid. In view of these circumstances, it must be confessed that, whilst there are certain features apparently incriminating the soil or dust of plague-houses, there is no conclusive evidence to the effect that plague is a telluric disease.

Most authorities are agreed that the bacillus has a very brief existence in water. Hankin states that he once found the bacillus in a tank. As the result of experiments, Abel asserted the bacillus survived for several weeks. Wilm gave it twenty days in distilled, sixteen days in spring, and six days in sea water. The more recent observations of Gaffky showed that the bacillus did not remain infective in distilled water for more than three days, whilst in ordinary tap-water it was not discoverable after twenty-four hours. I have not seen any statements concerning multiplication of the bacillus in water.

The foregoing facts express the essential features of such information concerning the extracorporeal existence of bacillus pestis as I have been able to collect after careful search through all the literature at my disposal. It has to be confessed that with the possible exception of clothing and house-dust, there is very little evidence that inanimate objects play any important part in the dissemination of plague. This view seems to receive confirmation from the statement that in the numerous experiments made by the German Commission to test the saprophytic properties of bacillus pestis, it was found that in no case did its infective power survive more than seven days.²⁹

It is also supported by the fact that plague incidence is conditioned neither by season nor meteorological factors; at all events, these agencies play no such obvious part as they do in certain other infectious diseases.

In addition to the facts already mentioned opinion is practically unanimous that the bacillus readily succumbs to germicidal agencies. It is quickly killed by direct sunlight, and less rapidly by free exposure to air. The gaseous

disinfectants act upon it quite as, or perhaps more, effectively than they do upon other disease germs, and it is easily killed by weak solutions of corrosive sublimate, carbolic acid, lysol, lime, mineral acids, &c. Nevertheless, in spite of the apparent ease with which the bacillus can be destroyed by very ordinary means, plague epidemics continue, no matter how vigorously such measures are applied. These facts suggest that the channels of plague dispersal are such as to protect the bacillus against the numerous influences which, if operative, would speedily ensure its extermination. Such security for the bacillus could scarcely exist elsewhere than in the body of its hosts, and one is led to think that the period of its saprophytic life, if it occur at all, is too brief and precarious to be at all significant from an epidemiological point of view. The transference from host to host must be more or less directly and rapidly accomplished.

As regards the human hosts of bacillus pestis, it has been abundantly shown that, save in the comparatively infrequent pneumonic form, plague is not conveyed by contagion. This is vouched for by various sets of facts; by the immunity enjoyed by doctors, nurses, and attendants upon the sick in hospitals, by the absence of cases amongst "contacts" segregated into camps or quarantine, by the absolute lack of association between successive cases, and by the fact that the disease is not specially incident upon overcrowded houses or areas, and does not for long remain confined to any particular quarter, but very soon begins to spread irregularly through a town or village. The suggestion afforded by the foregoing considerations is that there must be an intermediary host between man and man, and this rôle is now believed to be played by the rat.

As already stated, the rat is the one of all animals that most conspicuously shares with man the misfortune of being naturally susceptible to plague. In almost every place affected during the present pandemic, Hong Kong, Formosa, Calcutta, Bombay, Karachi, Oporto, in South America, and

here in Sydney, there has been reported great mortality amongst rats. In Hong Kong, it is said, one man alone collected 20,000 rats dead of plague, and in Formosa the disease is known as "rat-pest." The association of rats with plague is by no means a modern observation, but has been mentioned by many of the older writers. Mr. Hankin tells us that one of the most ancient books of the Hindus (Bagavathi Purana) explicitly warns the people of the significance to be attached to mortality amongst rats. "On the moment rats fall down from the roof above (*i.e.*, out of their nests) and jump about and die, they (the people) will at once leave their houses with their friends and relations and will go to a plain."³⁰ This direction is regularly observed by the inhabitants of Garhwal, and also, it is said, by those of Yunnan, who upon the occurrence of excessive mortality amongst rats immediately vacate their villages and go into camps until such time as experience has taught them they may safely return. But the fact that rats sicken and die in large numbers during plague epidemics is, indeed, too well established to need further consideration in this place.

Most commonly this feature constitutes one of the earliest indications of the presence of plague, and the primary incidence upon human beings occurs in the locality in which the rats are observed to be dying. It has been noted several times that the first persons attacked were those working about wharfs or in grain stores, places notoriously frequented by large numbers of rats. In Bombay the disease appeared in the quarter of Mandvi, and the victims were employed in grain depôts. In Oporto the first case occurred in a man who had been engaged in discharging a cargo of wheat. Here, in Sydney, as you are aware, the earlier cases were all associated in some way or other with those wharfs which receive most of the agricultural produce brought to the city. After a period of localisation to the vicinity of such places as those mentioned, the disease has usually spread slowly to other quarters, and this

extension, in addition to the incidence on man, has usually been marked also by mortality amongst rats.

The other most significant epidemiological feature exhibited during this diffusion is that the principal incidence is upon the poorer members of the community. This partiality has been so obvious that plague has earned the title of *miseriæ morbus*. The locality and habitations, and even the persons of the afflicted, have been generally reported as indescribably filthy. Dilapidated houses, accumulations of refuse, and defective sanitary arrangements, figure largely in all reports. They were existent in Canton, Hong Kong, Bombay, and Oporto, and of a surety Sydney cannot be cited as an exception. These conditions predispose to illness generally; but, more pertinently to our present inquiry, they attract and favour the entrance of rats into the houses. They are operative in the dissemination of plague only in so far as they do this, for plague does not necessarily attack the most insanitary or poverty-stricken parts of towns.

Apart from evidence of association of the kinds just mentioned there are many instances which show that the presence of a plague rat was responsible for the illness in man. For example, dead rats found one morning in a cotton factory at Bombay were removed by twenty coolies. Within the three following days about half of them fell sick with plague, whilst no one in the store not touching the rats was affected.³¹ Again, the coachman of an English family at Bombay found a dead rat in the stable and removed it. Three days later he fell sick with plague and died in a few hours. No other person in the same house was attacked.³² Various other observations of kindred kinds show only too clearly that the plague rat is a source of grave danger to human beings.

It is very commonly stated that whereas the rat is responsible for local dissemination, the disease is conveyed over long distances only by man. It is said that in many

of the Indian villages outbreaks of plague occurred after immigration of a sick person or persons from infected towns. But it has been observed that such "imported cases" were often the only ones to occur, and where indigenous cases arose it was most commonly after an interval of weeks during which the rats began to die of plague. The same sequence of events has happened with regard to many seaports. To London and to San Francisco cases came in ships, but no outbreak followed.

Whilst not denying the possibility of some mode of extension from man to rats that is yet undiscovered, it is not necessary to assume that it need occur. Where man goes, rats also can and generally do go. The transport of plague rats on ships is not merely a matter of conjecture, for, according to Simond, dead rats were found on the "Shanon" (Bombay to Aden) and "Patna" (Bombay to Karachi), and in each case were responsible for an outbreak of plague on board the vessel. There were also cases of plague on board the "Berenice" (Brazil to Trieste), "Polis-Mytilene" (Constantinople to Trieste), and "Taylor" (Brazil to New York), but in these cases nothing is reported concerning the rats. Few, if any, ships are free from rats, and these animals are commonly carried about with merchandise of various kinds on land. The possibilities of such conveyance are too numerous and too frequent to be eliminated, even by every practical effort that human forethought can suggest or human skill perform. It is very certain that as often as not there is no imported case in a human being, and the epidemic has, from its inception to its termination, expended itself entirely upon people who have never been away. The initial source of infection eludes the utmost vigilance, and that is precisely what rats would do. Infected rats getting ashore from ships would soon light up plague amongst their local associates, and thus lay the train for an epidemic.

Assuming the dependence of the importation and spread of plague by rats, there remains to be considered its decline.

In most places the epidemic has lasted from three to seven months and then subsided, at times completely, but usually only to recur again some months later. This course it commonly pursues, irrespective of seasons or preventive measures, for, as a writer has remarked, neither the elements nor the hand of man appear able to stay its progress. Observations upon rats again furnishes an explanation of the difficulty. It is well known that rats migrate, often in large numbers, either in search of food or for some other object. It is also known that they will avoid for some time any place where a few of them have died from poison. It is asserted by several Indian authorities that rats similarly migrate from places where they are dying from plague. They carry the disease with them and so spread it, but, continuing always to avoid the sick and dying, they at last become so dispersed that the disease dies out amongst them, and only the healthy rats remain. Following out this instinct of self-preservation, the rats of this particular generation are said not to return to their old haunts. Succeeding generations soon appear, and, slowly returning, re-occupy the evacuated quarters, which, as already mentioned, contain grain, refuse, &c., which attract them. If it should happen that the stragglers left behind at the time of migration have become free from infection all goes well, but if plague has persisted amongst them throughout, the incoming rats are again attacked, and then follows a recrudescence of plague in man. Simond asserts that the rats remaining behind become more or less immunised, and by retaining the infection in a mild form, thus keep it ready to break out when the progeny of the migrated rats return. In this way there is produced the succession of outbreaks so commonly observed in plague.

A great deal might be added to what has been said concerning the part played by rats in the incidence, dispersal, and decline of epidemic plague, but probably enough has been given to clearly show the nature of the evidence upon which the rat stands condemned as a source of infection for

human beings. The validity of it has been amply conceded by Koch, Cantlie, Manson, Simond, Hankin, Simpson, as well as numerous other authorities, including many members of the Indian medical and civil services.

It is to be noted, however, that this contention has some opponents. It has been said that in many localities near Bombay the disease ran its course without a single rat being affected; and, on the other hand, there appears to have been an outbreak amongst rats at Kunkhal which ran its course, and terminated without a single human being suffering. In the first case it may be that the incidence upon rats was merely unobserved, and the second obviously does not exonerate the rat from participation in other cases. It has been stated that comparisons have shown that the mortality from plague has been less in rat than in non-rat districts. Even if this be established, it will still remain to be demonstrated that in the latter places the part usually played by the rat was not assumed by some kindred animal. For, as already stated, Clemow has recently reported facts indicating that near Lake Baikal, in Siberia, a species of marmot (*Arctomys Bobac*) has been instrumental in spreading plague. But, apart from debatable points such as these just referred to, it is beyond question that numbers of persons have got plague without handling a plague rat, and numbers of persons have handled a plague rat without getting plague. In any case, how does the bacillus pass from the rat to man?

Suggestions with regard to the site of entry of the bacillus comprise the digestive tract, the respiratory passages, and inoculation. As already stated, infection by way of the gastro-intestinal tract is a controverted question, and infection by way of the air-passages is believed to occur only in pest-pneumonia, which never figures largely in epidemics. Consequently these two paths cannot be invested with any great epidemiological significance. Indeed, most authorities are in accord in regarding inoculation as the principal mode of infection. As you are aware,

the interpretation placed upon the development of the bubo is that the inoculation occurs in the area from which lymph is collected to pass through the affected gland. The great frequency of femoral buboes is regarded as an indication that inoculation most commonly takes place through the skin of the lower extremity, and in China and India this selection was accounted for by the habit of the native population in going barefoot. They were supposed to become inoculated by infected dust through wounds and abrasions on the feet. But it has been found that in countries where such a custom does not obtain the femoral region is still the most common site of the bubo, and consequently the theory of the "nu-pieds" no longer affords a satisfactory explanation. It is obvious, also, that none of the suggestions just referred to throw any light on the undoubted association of rats with epidemics of plague in human beings.

Upon this hitherto obscure feature of the dissemination of plague, we are now in possession of interesting data as the outcome of the researches of Simond.³³ This observer noted that persons becoming plague-stricken after handling a rat did not necessarily develop their bubo in the axilla. As often as not in such cases the bubo was femoral. The same authority states that a plague rat is dangerous or not in accordance with the time that has elapsed since it died. If handled soon after death, plague may follow, but if not touched for some hours, it may then be handled without risk. It was, says Simond, just as if the infection completely evaporated within a few hours after death. Finally, upon this point, Simond observed that in many instances there was, on the area corresponding to the affected gland, a local lesion, a phlyctenule, which he regards as marking the actual site of inoculation, and in which plague bacilli are to be detected. The occurrence of such a phlyctenule is vouched for by several other investigators,³⁴ though not all concur in Simond's interpretation of it. This local lesion is not always apparent, and, in fact, in the majority of cases,

it is not to be found ; but this frequent absence, Simonds contends, is due to the fact that it would only be produced when the inoculated bacilli were of comparatively mild virulence. Under such conditions there would ensue positive chemiotaxis, local leucocytosis and reaction, whereas, if the bacilli were very virulent, the chemiotaxis would be negative, and no such local reaction occur. However this may be, Simond believes that the phlyctenule represents the point at which the bacillus found entry, and that it was produced by something that passed from the body of the rat to that of man, the said something being in his opinion most probably a flea.

He found by observation that perfectly healthy rats harbour very few fleas, and were very expert in removing them, but as they became sick they neglected their toilet, and fleas became more and more abundant upon them, so that they sometimes swarmed upon moribund rats. After death, on cessation of the circulation, and as the body becomes cold, the fleas leave it and seek another host. In this way he explained the " evaporation " of the risk attendant upon handling a dead plague rat. If the fleas from the dead rat reach another rat or a human being, they may inoculate the bacilli they acquired by ingesting the blood of their former host. In this way, according to Simond, the plague spreads from rat to rat, and from rat to man. The man who handles a plague rat may be bitten by the flea, not on the hand or arm, but on the leg, and so the bubo be femoral. So it may happen that a person who has not had to do with a plague rat, may yet be invaded and inoculated by the flea from it. It is enough that plague rats have recently died in the house or place.

By way of further substantiating his views, Simond demonstrated the presence of plague bacilli in the bodies of fleas from plague rats, and produced the disease by inoculating such fleas crushed up with sterilised water. To the still further objection, that the flea may contain bacilli in

the stomach, and yet not give plague by biting, Simond's researches supply the following answer. He placed in a large glass jar a sick rat, and also a healthy animal (rat or mouse), the latter being enclosed in a small cage so as to prevent contact with the sick rat. If he left or placed fleas upon the sick rat, and allowed its body to remain lying in the jar for some hours after death, the healthy animal sometimes developed plague and died; but if he previously removed all the fleas from the rat, and repeated the experiment otherwise precisely as before, the healthy animal did not die, but remained perfectly well.

It must be admitted that Simond supports his flea theory at every possible point, and in doing so has performed a most interesting and suggestive piece of work. It still awaits confirmation by other observers, but meanwhile there is every reason to regard it as perfectly valid. Nowadays we accept the intervention of parasites with regard to many diseases—the mosquito in malaria, the tse-tse fly in African horse-sickness, and the cattle tick in bovine tick-fever; and in none of these is the proof any more complete than that which Simond has furnished with regard to the flea and plague. The theory is perhaps not absolutely exclusive of other agencies. The bacilli have been found in bugs, flies, and ants, but, with the possible exception of the first, it is not likely that these animals play any significant part in plague epidemics. Admitting cases of accidental inoculation, of occasional contagion, of direct passage of fleas or bugs from man to man, and perhaps rarely the operation of some other obscure mode of conveyance, the great bulk of cases is not to be explained in any such way. Simond's hypothesis accounts for most of them and for much else that was formerly mysterious in the epidemiology of plague. The apparent infectivity of linen and clothing and of plague-houses and the influence of poverty, squalor, and dirt may easily be due to the harbourage such things afford for plague fleas. Even if we do not accept the evidence as entirely conclusive, nevertheless it is quite good enough to justify

the adoption of the theory as a guiding principle in our efforts to combat plague. By so doing we lose nothing, and probably gain a great deal.

For if we agree with the dictum of Koch, that plague is essentially and primarily a disease of rats, or, as Manson puts it, that plague is a rat-borne disease, the direction which preventive measures should take is precisely that which will save us from the plague flea. I need not spend time in discussing such measures in detail. The destruction of rats and of all conditions which encourage or favour or facilitate their collection in the neighbourhood of habitations must be carried out by every means in our power. There must not be sudden and spasmodic onslaughts with intervals of quiescence, but a continuous, persistent, strenuous effort to suppress and keep suppressed the rat and everything that favours its existence. This course of action must be maintained after the cessation of an outbreak, with a view of preventing its recurrence. No doubt the undertaking is a very large one, involving municipal and domestic cleanliness of a higher order than is usually considered necessary, but it is demanded of us, not only as a preventive of plague alone, but as the means of reducing the incidence of many other infectious diseases as well.

Upon the subject of prophylactics and curative serums I have nothing to say in this paper. You know what the prophylactic is, and most of you have had practical experience of what follows its injection. As to the protective value, I can at present add nothing to what has appeared in our journals. With regard to serums, the Department expects soon to test their efficacy, and I prefer to await the experience before expressing opinions on the subject.

You will notice that in compiling this paper I have not drawn much upon our Sydney experiences, the account of which will reach you later on through the proper channel. But I have no doubt you will have perceived, from facts

within your own knowledge, that our epidemic parallels in most respects those occurring elsewhere, and that you fully appreciate what was said concerning fixity of type in an early part of this paper.

Notwithstanding that plague as an epidemic possesses such very clearly marked characteristics, it is a curious fact that there has nearly always been exhibited a tendency to deny its epidemic existence at its first appearance in any particular place. In the olden days people would assert that the disease was a "transmutation of malarial fever," or "typhus genius epidemicus," whilst more recently we hear it referred to as "malignant typhoid" or "continued fever with buboes," whatever that may mean, and in fact anything but plague. Dr. Neild Cook, the medical officer of health at Calcutta, remarks that the physician who diagnoses the first case is almost invariably ridiculed. The consequence of this attitude cannot be better expressed than in the words of a writer upon the outbreak at Alexandria: "The attitude taken up by the Press is not to be admired. At one moment it denies that the disease is plague at all, jeering at the sanitary authorities for excessive zeal, and demanding a close time for the *chasse aux bubons*; at another moment, under the influence of hysterical excitement caused by the occurrence of a fresh case, it proclaims loudly that nothing is being done, and demands the burning down of infected houses, the absolute isolation of medical officers and all who have seen a plague case, the establishment of special Commissions of intelligent citizens, &c., &c."³⁵ I bring these matters before you without comment, and merely by way of showing that our own community has not been at all singular in its behaviour in the face of plague.

Finally, I ask you to believe that in venturing to respond to the Secretary's invitation to address you, I do so without the least intention of posing as an expert, or speaking with any official authority. My colleagues and I have had, perforce, to inform ourselves as fully as possible in this matter. They have obligingly aided me in the preparation

of this paper, and I ask you to look upon it as being no more than the expression of our joint desire to share with you in every possible way such information as we have been able to collect on the subject of plague. I have to express my gratitude to my laboratory assistants, Messrs. Robert and George Grant, for their able help in preparing the exhibits, and to thank you for the patient hearing you have given to my very long dissertation.

REFERENCES.

1. Payne, Allbutt's System of Medicine, Vol. 1, p. 920.
2. Hankin, The Bubonic Plague, p. 28.
3. Simond, Propagation de la Peste, Ann. Inst. Past., 1898.
4. Clemow, Journal of Tropical Medicine, Feb., 1900.
5. Hirsch, Geog. and Hist. Path., Vol. 1, p. 494.
6. The Bubonic Plague, pp. 11-13.
7. Simpson, *B.M.J.*, 1899, Vol. 1, p. 697.
8. *Ibid.*
9. *B.M.J.*, 1898, Vol. 2, p. 862.
10. Simpson, *loc. cit.*
11. Cantlie, Practitioner, Nov. 1899, p. 527.
12. Cantlie, *loc. cit.*
13. *B.M.J.* 1899, Vol. 2, p. 1646.
14. Exact figures not available.
15. *B.M.J.*, 1897, Vol. 2, p. 419.
16. *B.M.J.*, 1898, Vol. 2, p. 859.
17. *Ibid.*, p. 861.
18. Sur. la Peste Bubonique, Ann. Inst. Past., 1897, p. 737.
19. *B.M.J.*, Sept. 23, 1899.
20. Annales Inst. Past., Dec., 1899, p. 865.
21. *B.M.J.*, 1899, Vol. 2, p. 1588.
22. *B.M.J.*, 1896, Vol. 2, p. 1739.
23. Practitioner, Nov., 1899, p. 530.
24. Hirsch, Geog. and Hist. Path., Vol. 1, p. 526.
25. Analysis of the Evidence given before the Plague Commission, 11, *B.M.J.*, 1899, Vol. 1, p. 873.
26. Major R. Barker, *B.M.J.*, 1898, Vol. 2, p. 86.
27. Hirsch, *loc. cit.*
28. Allbutt's System of Medicine, Vol. 1, p. 526.
29. *B.M.J.*, 1897, Vol. 1, p. 1248.
30. The Bubonic Plague, p. 22.
31. Simond, *loc. cit.*
32. *Ibid.*
33. *Ibid.*
34. Childe, *B.M.J.*, 1898, Vol. 2, p. 861.
35. *B.M.J.*, 1899, Vol. 1, p. 1552.

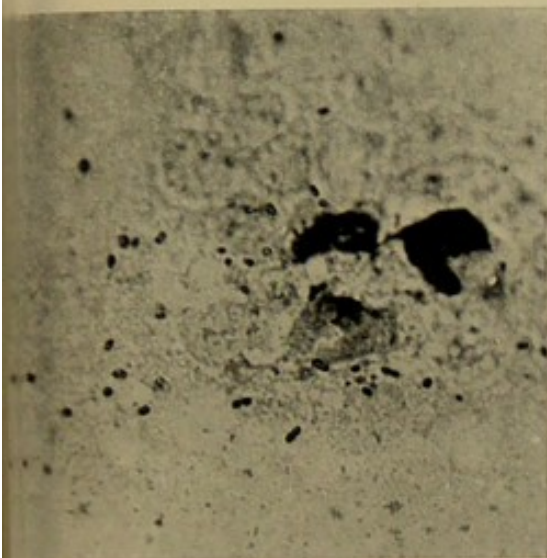


FIG. 1.
SMEAR PREPARATION FROM BUBO.



FIG. 2.
PREPARATION FROM BLOOD OF HEART.

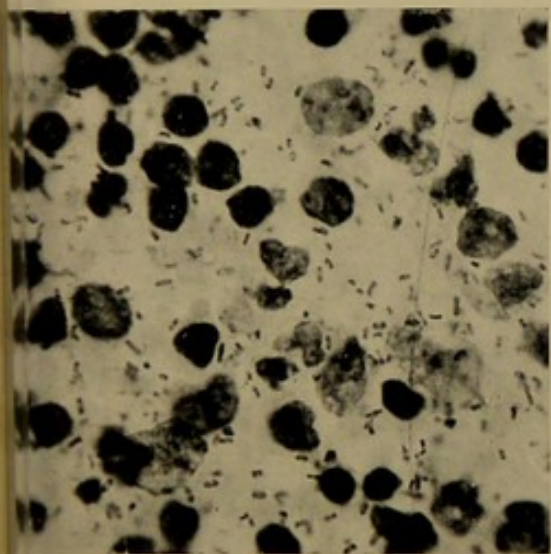


FIG. 3.
SMEAR PREPARATION FROM SPLEEN

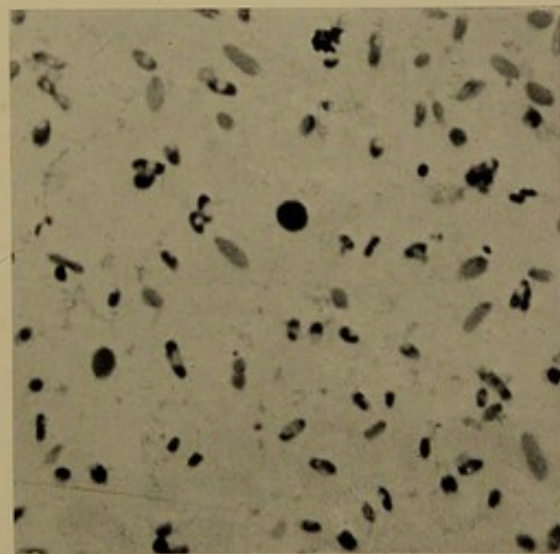
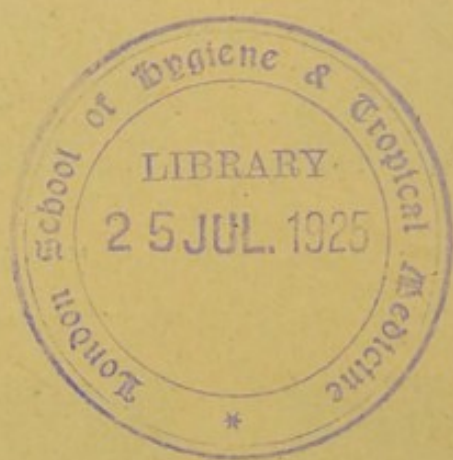


FIG. 4.
PREPARATION FROM DRY AGAR CULTURE.
INVOLUTION FORMS.

PLATE 1.

BACILLUS PESTIS BUBONICÆ.



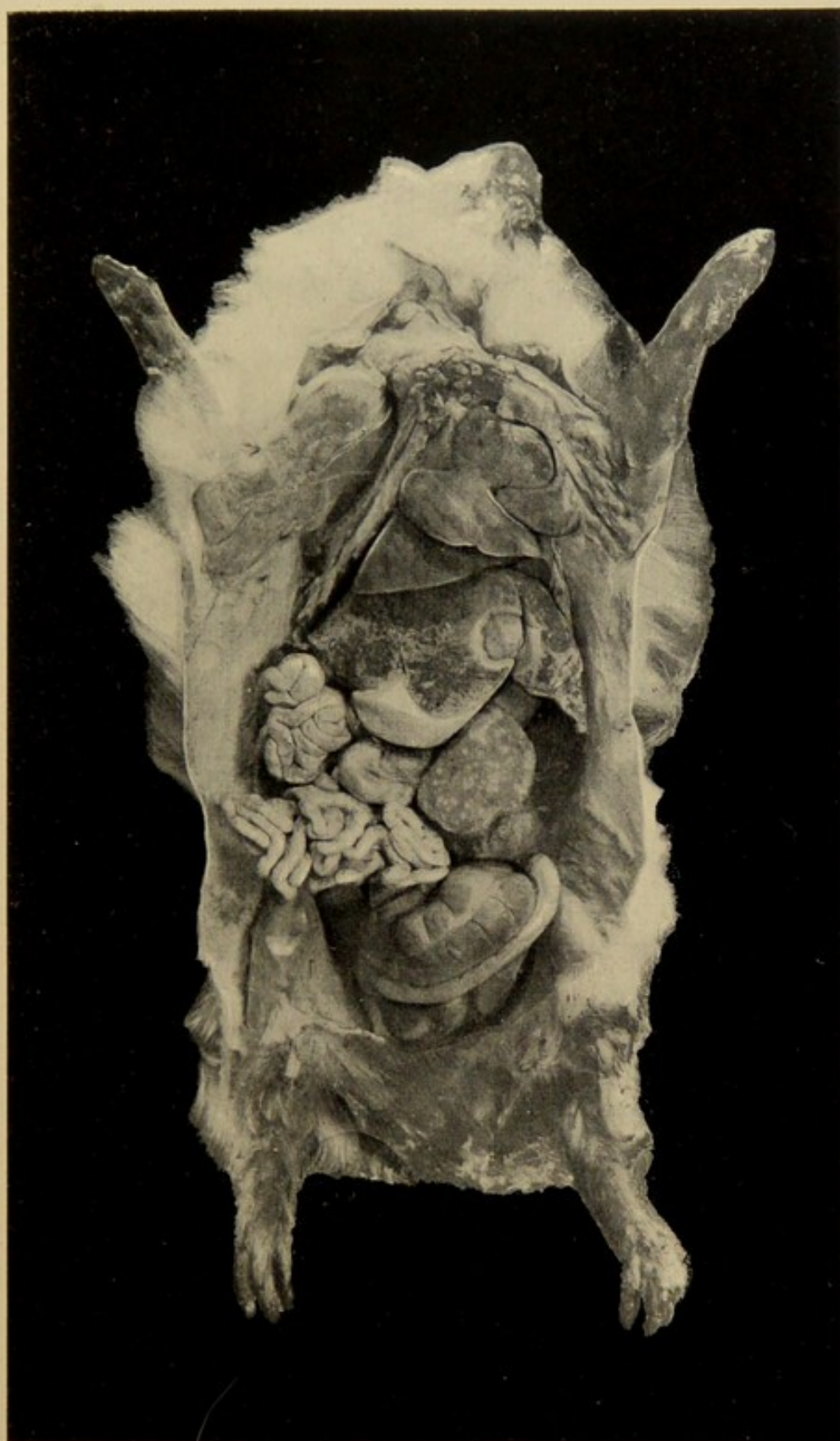


PLATE 2.

PATHOLOGICAL APPEARANCES IN A GUINEA-PIG DEAD AFTER INOCULATION WITH
BACILLUS PESTIS BUBONICÆ.



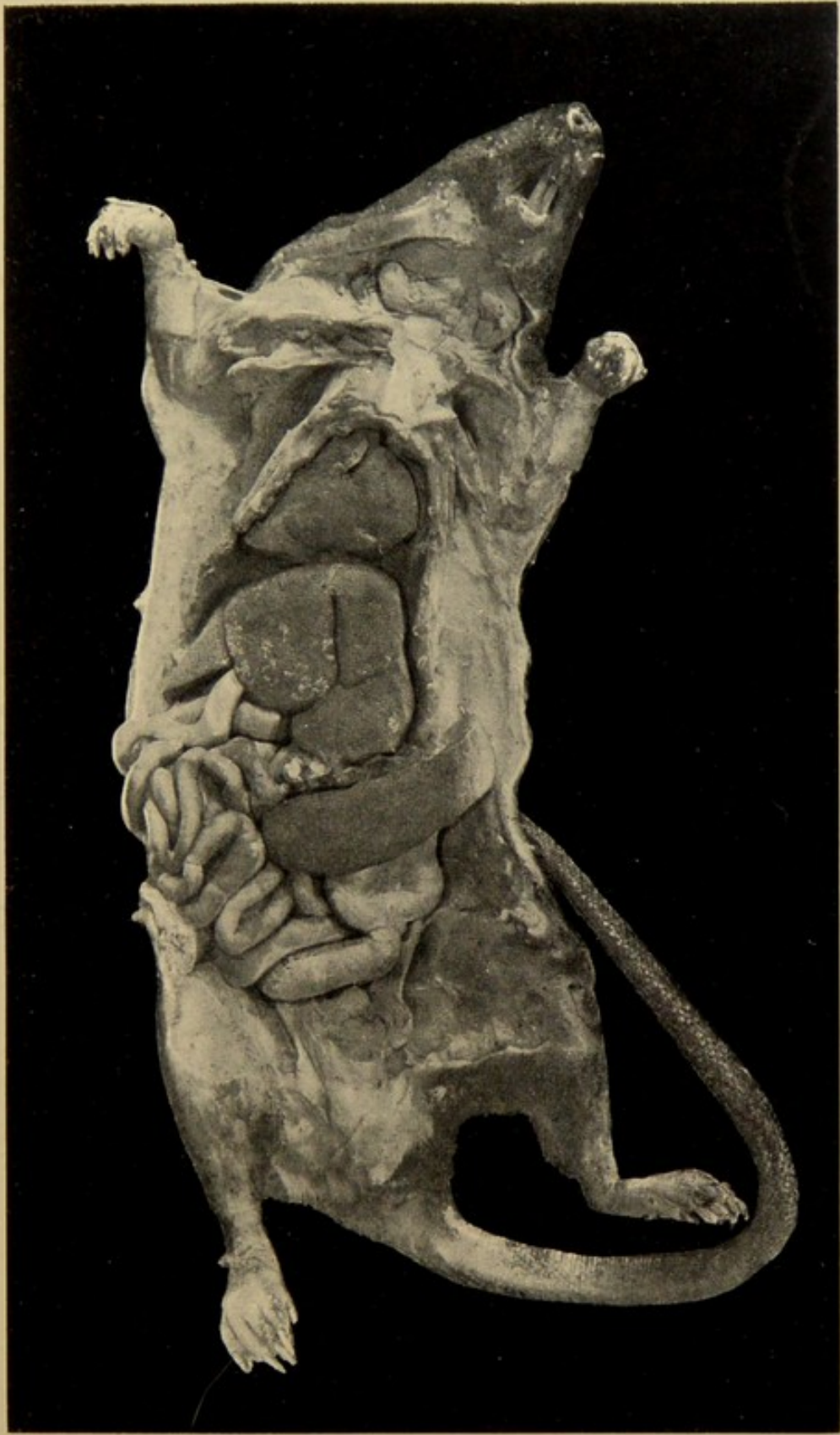
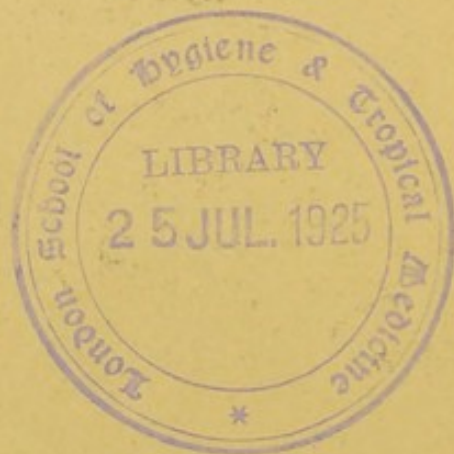
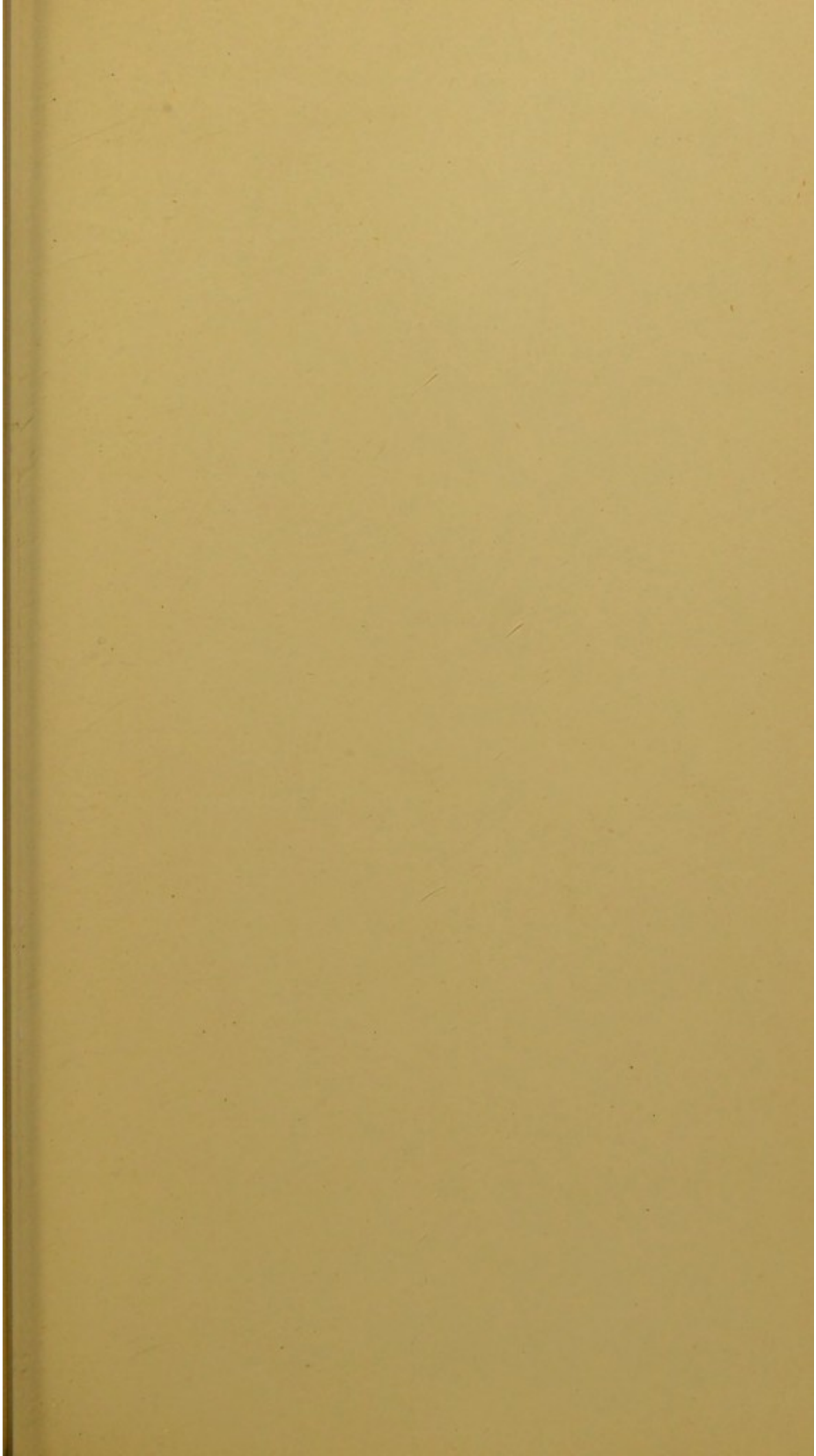


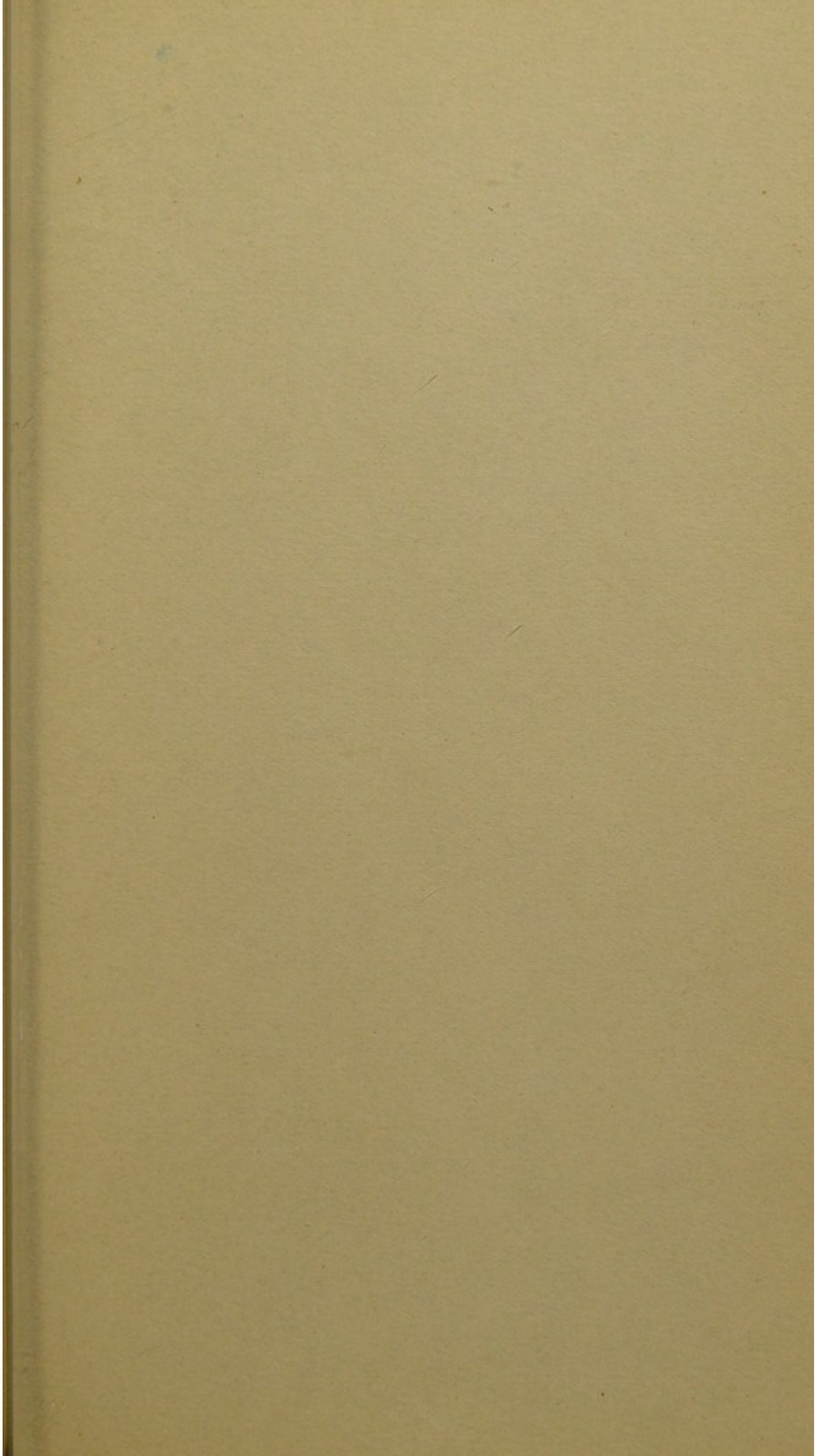
PLATE 3.

PATHOLOGICAL APPEARANCES IN A RAT DEAD AFTER NATURAL INFECTION WITH PLAGUE.







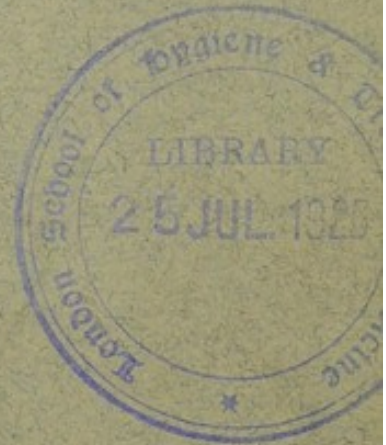




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THE SANITARY INSTITUTE.



SOME PRACTICAL ASPECTS OF THE PLAGUE AT SYDNEY.

BY

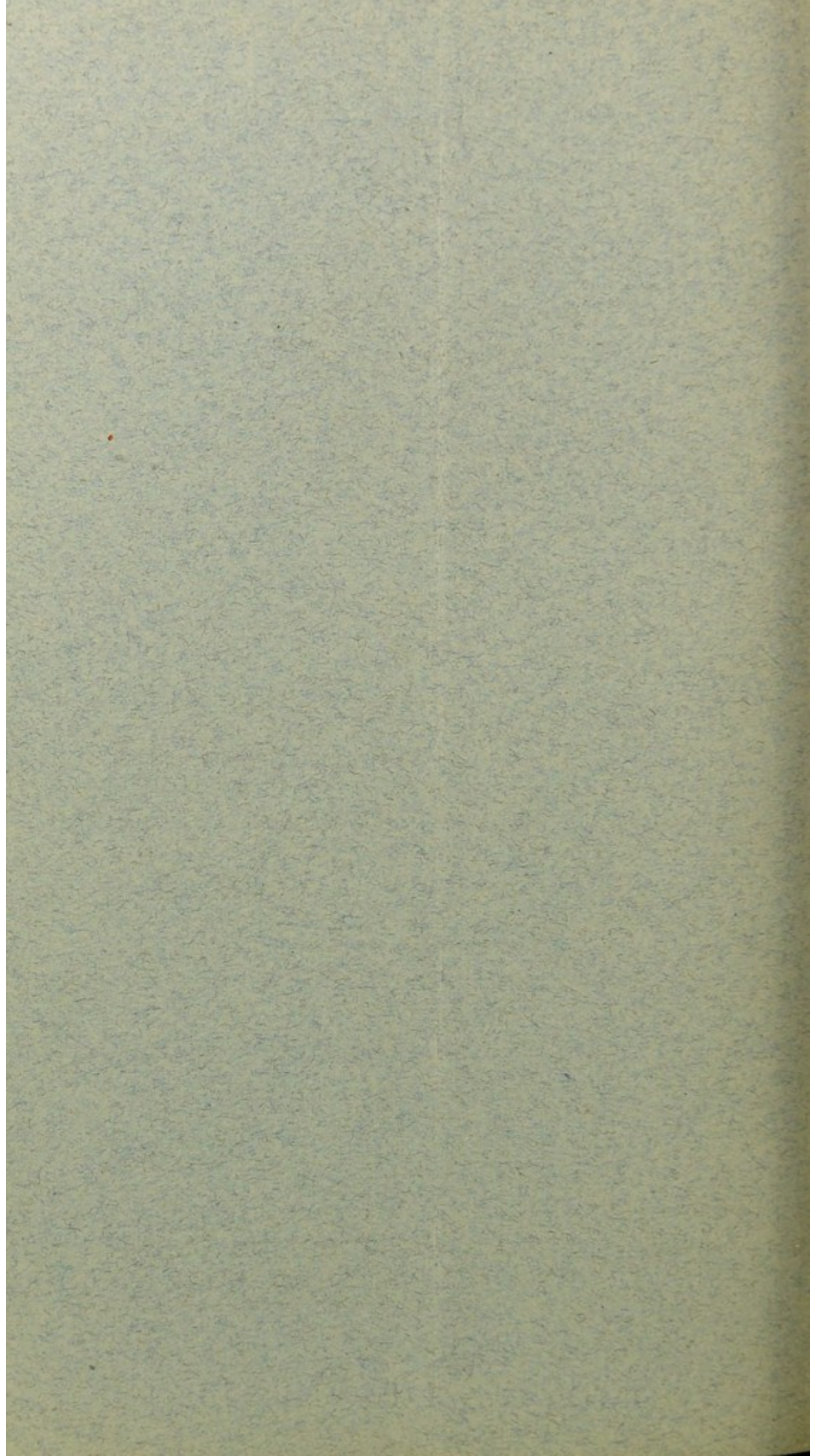
FRANK TIDSWELL, M.B., CH.M., D.P.H.

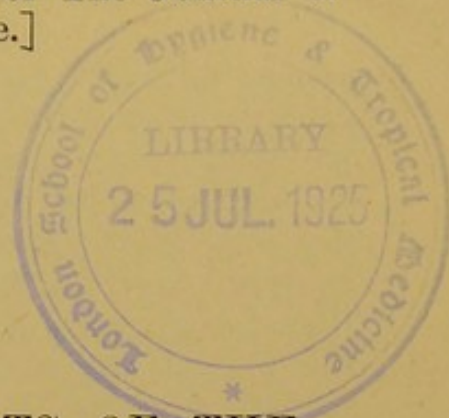
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SOME PRACTICAL ASPECTS OF THE PLAGUE AT SYDNEY.

BY FRANK TIDSWELL, M.B., CH.M., D.P.H.

Principal Assistant Medical Officer of the Government of
New South Wales.

(MEMBER).

Read at the Sessional Meeting, December 12th, 1900.

IN responding to the honour of the Committee's invitation to address you on the subject of the plague at Sydney, I am not prepared to present a connected account of that epidemic. The official report, which will soon be available to you, is much more complete and satisfactory than anything I could reproduce from memory. I have to ask your acceptance of a paper unavoidably sketchy, as owing to the lack of means of reference to precise data and documents, I am obliged to offer you broad outlines rather than detailed pictures. But this is perhaps not much to be regretted since classical descriptions of plague have now become so numerous, that it is little short of an infliction to have to read, let alone write, another. With this claim upon your indulgence, I venture to invite your attention to some items of our experience in Sydney as regards, (1) the recognition of plague, (2) its mode of dissemination, and (3) the preventive measures applied.

(I.) THE RECOGNITION OF PLAGUE.

The incidence of plague on Sydney was to some extent anticipated. That is to say, its wide dispersal during the last few years, and especially its southerly trend, led us to prepare ourselves, as far as possible, to meet and cope with it should it

appear amongst us. But so far as the recognition of the disease was concerned, we had to depend on the mental picture we could form by perusal and analysis of available descriptions: for none of us had had any practical acquaintance with plague, nor was there in our medical community any gentleman so equipped to whom we could look for aid. It thus came about that, for my own part, I awaited the expected crisis with all the doubts incidental to untested conceptions. As a matter of fact the first case was a perfectly clear and straightforward one, and thus fortunately was recognised without difficulty. But our subsequent experience was to the effect that whilst the majority of our cases were equally easy of diagnosis, we would now and then meet with one concerning which we could express no decided opinion on the clinical evidence presented. Speaking generally, one may say that given a case exhibiting symptoms common to several acute febrile diseases, the only clinical manifestation that obviously invests it with the specific character of plague is the existence of a bubo. In the absence of this indication one can rarely be more than suspicious that the case is plague; the final adjudication, if forthcoming at all, is expressed by the bacteriologist, or only delivered at the *post-mortem* table. Hence it appeared to me that the points of most practical importance in the recognition of plague were associated with (*a*) the characters of buboes, (*b*) the indications other than buboes which should induce a suspicion of plague, and (*c*) the means of obtaining a bacteriological examination. I have therefore selected these three matters for consideration in this part of my paper.

Buboes.—I am unable to state from memory the exact proportion of bubonic cases in our epidemic, but that type of the disease was exhibited by the great majority of our patients. We had one or perhaps two pneumonic, and the rest were septicæmic. But I may here observe that although the same type was usually preserved throughout the illness, this was not always the case. Bubonic patients commonly became septicæmic and showed bacilli in the blood, and sometimes there was a secondary pneumonia, with bacilli in the sputum. Such mutations cannot be predicted, nor can they always be detected. I call attention to them in this place merely as an indication that it is not wise to attach a too rigid interpretation to the terms used in classifying the cases in an epidemic.

Our experience was not altogether in accordance with the statement that buboes usually appear on the third day of illness. We generally found them present on the second, and in many cases on the first day, whilst in a few instances they were amongst the very earliest symptoms noticed by the patient.

I recall upon this point the instance of a man, who first felt sick about noon, and developed a painful swelling in his groin about 4 p.m. on the same day. When I saw him next day at 2 o'clock—twenty-six hours after his falling sick—the bubo was already as large as a pigeon's egg, and formed a visible prominence in the left femoral region. In another case the first indication of illness was a sharp pain due to a bubo in the groin suddenly experienced whilst the patient was walking along the street. From our own cases I should have inferred that the bubo usually made its appearance before the third day of illness.

We had a preponderance of femoral buboes, although again I cannot state the exact proportion, nor the relative numbers on the two sides. It was most usual to find the lowest gland of the femoral group enlarged either alone, or to a greater extent than the others, but, as might be anticipated from anatomical considerations, this was not invariably the case. I am not quite sure whether inguinal or axillary buboes were next in order of frequency, but I think there was not much difference between the numbers. It was not common to find an inguinal bubo alone; there was generally some associated swelling of the adjacent femoral glands. In the axillary region, the bubo was frequently situated in a true gland of the armpit. One had to feel well up in order to palpate it. But there was a fair number of cases in which the bubo occurred in a gland under the outer edge of the pectoral muscle, and was not therefore a true axillary bubo. It happened on one occasion early in our epidemic that a bubo in this situation was overlooked at the first examination. It was then very small and did not happen to be pressed upon during palpation of the axilla. It revealed itself later, but the incident taught us to carefully palpate with slight pressure all glandular regions, whether indicated or not by the patient as a site of discomfort or pain. I may add that in a sick cat forwarded to the laboratory for examination and found to be suffering from plague, such a sub-pectoral gland was the site of the bubo. Cervical buboes were not very common, and when they occurred generally affected the glands in front of the sternomastoid muscle. We did not meet with any instance of popliteal bubo, and although in one case there was a swelling of the epitrochlear glands, specimens taken from it for bacteriological examination were repeatedly examined with negative results.

In speaking of buboes in the foregoing remarks, I would be understood as referring to the primary glandular swelling. As a rule indeed there was only one, or merely local extension

from one group of glands to another in its neighbourhood. I have already mentioned the association of inguinal and femoral swellings, but in addition to this it was very common in purely femoral cases to elicit tenderness on pressure above Poupart's ligament. The indication thus afforded of extension to the iliac glands received confirmation by *post mortem* and experimental observations. But apart from such cases, enlarged glands were occasionally present in two totally different regions, as groin and axilla, or axilla and neck. They were sometimes on the same, and sometimes on different sides of the body. In a few instances there were bilateral enlargements, always either femoral or inguinal or a mixture of both, but the symmetry was never quite perfect—one side being more advanced than the other. I cannot say that the subsequent development of the second swelling, or of either of them, was in any way affected by the existence of the other.

As a general rule the buboes appeared quite suddenly, and enlarged rapidly. In the course of twenty-four hours the glands sometimes attained the size of a pigeon's egg, or even that of a walnut. But on the other hand, occasionally they never became bigger than a marble. It was usual to find several glands of a group enlarged, but one much more than the others. The detection of the gland itself, however, depended on very early access to the case. If this were obtained it was usually easy enough, by the rounded or oval shape, well-defined limits, &c., to satisfy oneself of the existence of a swollen gland. But it was not many hours before this became impossible, owing to the occurrence of hæmorrhagic exudation and œdema round the gland. When this had happened all that could be felt, as a rule, was a diffuse thickening in the region, having no definite shape nor margin. The amount of exudation, like the degree of swelling of the gland itself, was very variable. Sometimes it formed a mass filling up and causing a projection in the groin or axilla, and at others it was so scanty as to be scarcely evident. When the gland itself could be felt it was tense rather than hard, its consistence being, to my mind, comparable to that of the testicle. The periadenitic effusion was more or less firm, at all events at first, but later on it sometimes became soft enough to take an imprint of the fingers.

The skin over the bubo remained normal in colour for a time, and then became reddened, whilst with the approach of suppuration it assumed a more violet tint. Sometimes in the later stages it showed discoloration as in a bruise, and in one or two instances there was actual hæmorrhage of a petechial character.

In nearly all cases the bubo was very tender; in some cases

exceptionally so—the patient flinching and guarding it with his hand, or begging that it might not be touched. But usually gentle manipulation could be borne, and sometimes the swelling could be pretty freely handled without causing any great amount of pain. Apart from handling, the sensation in a bubo was described as a dull ache rather than actual pain, but this was often severe enough to induce frequent requests for renewal of hot applications, which seemed to be of great comfort to the patients. Any movement involving pressure on the bubo caused acute pain, and quiescent patients sometimes assumed positions which would minimise such pressure. Those with groin buboes would flex their thighs at the hip; those with axillary bubo hold their arm away from the side, and those with cervical buboes keep their head rigidly bent towards the side on which the bubo was situated. In a few instances the bubo appeared to be painless whilst the patient remained quiet. It may be that an impression of painlessness was often due to the patient not being able to appreciate his own sensations owing to mental depression or aberration.

The ultimate fate of buboes included resolution, suppuration, and sloughing and ulceration,—the exact issue depending upon the stage at which the inflammatory process stopped. Resolution was sometimes remarkably rapid, all sign of the swelling disappearing in a fortnight or three weeks from its first appearance. It was more common, however, for the signs of active inflammation to subside within this period, and the swelling to remain as a practically insensitive lump, gradually diminishing in size during the course of one or two months. The buboes that suppurated were opened in the usual way, and usually contained sanquinolent or creamy pus; occasionally shreds of necrotic tissue. After opening, the discharge became thinner and serous in character. Very often the sinus healed up in the ordinary manner, but sometimes its edges broke down and left a ragged ulcer, which ultimately went through the slow process of granulation.

It resulted from these various modes of fermentation, that whereas some patients were quite well and able to leave the hospital within three weeks of their admission to it, there were others who had to be detained for nearly as many months. This was a practical point in the management of the isolation hospital, as the accommodation became strained now and again, owing to the accumulation of such convalescents. We had some doubt as to the proper way of dealing with that class in which the buboes, though inactive, nevertheless persisted as lumps. Our hand was forced to some extent by the pressure on our accommodation, and after observing the first few cases,

we reluctantly had to let the rest go as soon as we were satisfied that inflammation in the buboes had really ceased. Of course, they were also completely free from constitutional symptoms. There is no theoretical reason really opposed to this procedure, and nothing against it appeared in our practice. It seemed to be a perfectly safe thing to do. But the question of patients with open sores was another matter. They were perfectly well except for the local lesion, which was sometimes very small. But although our own observations were in accord with the statement that plague bacilli cannot be detected in the discharges after a certain time, we did not feel justified in releasing such patients whilst any sign of discharge remained. Consequently, they accumulated in the hospital, blocked up beds, filled the convalescent wards, and so impeded the proper reception of acute cases. They thus constituted a real practical difficulty for which we discovered no solution.

Indications of plague other than buboes.—Failing the detection of a bubo, the opinion one can form amounts to a more or less well-grounded suspicion, based as far as I was concerned on general indications rather than precise symptoms. I do not wish to imply any neglect to ascertain, and estimate the significance of, the state of the temperature, pulse, tongue, etc., but that in plague, as in most other diseases, the search for characteristic physical signs was practically consequent on the impression afforded by the general aspect of the case. I have therefore elected to endeavour to portray the general conditions in which we found our various patients, adopting this course the more readily since the detailed symptoms exhibited by them were in accord with the many excellent descriptions now available, and with which you are no doubt familiar.

I call attention in the first place to cases in which the incidence was so swift, and the virulence so great, that the only suspicious element was the sudden death of the patient, and the only means of verification the *post-mortem* examination of the body. Thus there was one case in which a man, who had got up, taken his breakfast and gone out in accordance with his usual custom, was drinking at a bar when he complained of feeling very giddy and sick. He remained depressed and miserable for some time, and then went to the back premises of the hotel. A little while afterwards he was found dead in an outhouse. It was only at the autopsy that he was ascertained to have been stricken down by plague. There was another case in which a young girl fell sick one afternoon with headache, vomiting, etc., her attack being such as commonly follows, and was actually ascribed to, some dietary indiscretion. She died next day before noon, and on examination

her organs generally were found to be teeming with plague bacilli. I may also mention that in another case in which the illness was recognised, the interval between the first symptom and death was only eighteen hours. These illustrations serve to show that our epidemic was not wanting in fulminant manifestations, the plague toxin occasionally exhibiting a potency little, if at all, less than that possessed by some of the vegetable alkaloids and mineral poisons.

Next in intensity to those already quoted came cases in which the incidence was equally rapid, but the virulence of less extreme degree. Amongst these were many instances of men becoming prostrated whilst at their work, to which they had gone in the morning without the least suspicion of being otherwise than in their ordinary state of health. For example, a printer had gone to business and worked at his machine for several hours. About mid-day he was seized with violent headache, nausea, and abdominal pain of a colicky character, and in a few minutes was stretched, pallid, tremulous, and prostrate, on the floor of the workshop. About three hours afterwards, when we saw him, he was lying upon some sacking with blanched face and closed eyes, helpless, motionless, speechless, in a condition of torpor from which he could not be roused. He was sent directly from the workshop to the quarantine hospital, and next day developed a bubo in his groin. This degree of prostration, though not often reached so quickly, was comparatively common in cases after admission to the hospital. Absolute unconsciousness was unusual, save as the immediate precursor of death, but a condition of profound apathy was very frequently seen. The patient would generally lie curled up in bed, on one or other side, but sometimes assumed the position of dorsal decubitus. There was no rigidity about either position, the patients could be easily moved into any other, and sometimes changed on their own accord. But having taken up such a position they would remain in it for hours, lying quietly with their eyes closed, perfectly indifferent to their surroundings, content so long as they were left alone. If disturbed they would wearily open their eyes for a moment and bestow upon one a vacant glance, perhaps frightened, perhaps reproachful, and promptly relapse into their torpid condition. They would swallow liquid food and medicine poured into their mouths, submitting to this and other necessary attentions without apparently the least appreciation of what was being done to them. Even the handling of the bubo usually failed to produce more than a wincing of the face expressive of pain, unaccompanied by any movement of resistance. This condition sometimes ran on to coma and death, and sometimes passed

away in a few days, leaving the patient very weak but convalescent.

The next type of illness to which I direct attention was that exhibited by the majority of our patients. The onset, though still rapid, was not so appallingly sudden as in those already mentioned. There was an interval of some hours between the premonitory symptoms and prostration, during which the patients were usually able to get home to bed. The very first case of the epidemic occurred in a carter who had gone to work in the morning feeling perfectly well, as was usual with him. About twelve o'clock, whilst driving his team, he suddenly developed violent headache, giddiness, and nausea, which compelled him to tie up his horses and lie down. He could not eat his lunch and continued to feel sick, but he managed to resume his journey and completed it about four o'clock. At that time he felt a pain in his groin and on examination found a lump there. He reported himself sick, put up his horses and went home to bed. He is said to have vomited and been very sleepy and feverish during the evening. He was visited next day at noon by his private medical attendant, and in response to a report by that gentleman I saw the patient at two o'clock. He was then curled up in bed as if sound asleep, but he roused at once when I spoke to him. His face was pale, with a febrile flush on the cheeks, and his expression that of a man not quite conscious of his whereabouts. He answered my questions in a weary kind of way, but quite intelligently, and although speaking slowly the enunciation of words was perfectly clear. He professed feeling very weak, comparing his condition in this respect to those experienced in a previous attack of influenza. He could easily move about the bed and sat up without assistance when requested to do so, but he evidently preferred the recumbent posture, resuming it as soon as possible. For the rest I need only mention that he had a temperature of 105.4° , a rapid but fairly strong pulse, and a left femoral bubo as large as a pigeon's egg.

The picture here presented, though a common one, was often modified by a much greater degree of torpidity. The patients could be less easily roused from their sleep-like condition, and on being left alone promptly relapsed into it. When so lying in bed the expression on their faces sometimes suggested dreaming, and whilst at others placid, it was never entirely vacant. When roused up the expression was often one of anxiety, fright, or bewilderment, as when a person is awakened from deep sleep. They would answer questions, or attempt to do so, often exhibiting the clipped or mumbling speech mentioned by authors. Their drowsiness often resulted in their not following

what was said to them, and in their failure to utter more than half sentences, forgetting the rest. They were generally bid-able, being too sick to resent or resist interference, and moreover they could generally be made to appreciate the efforts made for their comfort. The positions assumed were also indicative of the retention of sensibility, for in these patients one observed the attitudes designed to relieve pressure on a bubo, viz., flexion of the thigh, elevation of the arm, &c. The condition was of variable duration, and of no significance as to the ultimate issue of the case.

In other instances, although the onset itself was not excessively rapid, there was a period at which the symptoms would suddenly become distressingly acute. For example, a young man having spent the evening socially at a friend's house, went home and retired to bed, apparently in his usual state of health. During the night he vomited, and next morning complained of nausea and headache. He did not go to business, and appeared to get better during the day. Towards evening he became listless, drowsy, and light-headed, and when seen at midnight he was flushed with fever, quite prostrate, and delirious. He was transferred to the Quarantine Hospital early next morning, and in that institution had a series of hæmorrhages from the mouth, nose, and bowels, developed a purpuric rash, and died on the fifth day of illness during copious bleeding from the lungs. It was not often that patients were found delirious at an early stage, this condition more commonly supervening after admission to the hospital. The delirium was generally noisy, taking in some cases the form of incessant chattering, and in others that of more or less frequent spasmodic outcries. In nearly all cases the utterances were incoherent, babbling, and meaningless, with perhaps a single word distinguishable here and there. Associated with the mental, there was also muscular unrest, tremors, spasmodic contractions, or purposeless movements of the limbs or head. Rarely a patient would excitedly sit up in his bed, or try to get out of it, and sometimes struggle when his efforts were resisted.

In connection with the class of case now under consideration I may perhaps be permitted to cite one illustrative of the mode of attack in a young child. A little boy, aged two years, had been bright during the day, but was noticed to be unusually quiet in the evening. During the night he had a series of convulsions. Next morning the child was admitted to one of the general hospitals. There he lay all day in his cot, very pale, drowsy to torpidity, having no regard for food, nor the surroundings, and making no sound unless disturbed, when he uttered plaintive cries. This condition, for which there was

no discoverable cause, roused the suspicions of the superintendent, and in our joint examination of the case next day we discovered a bubo in the axilla, fluid obtained from which contained an abundance of plague bacilli. The child died early next morning.

The series of cases just quoted represent conditions sufficiently serious to arrest attention, and lead to further investigation. Hence they usually came under our notice at an early stage, and presented no special difficulties in the matter of diagnosis. But interspersed amongst them were many which failed to suggest the idea of plague, by reason of the mildness of the symptoms at the time they were examined. In these cases the onset was sometimes comparatively slow, and the amount of enfeeblement moderate. Suspicion attached to them mainly on account of their unexplainable illness having occurred during the prevalence of a plague epidemic. Such patients would sometimes be found in bed, complaining of the general aches and weariness that so commonly precede the onset of a fever, and often indicated the lumbar region of the back as the site of their greatest intensity. The recumbent attitude, however, was more a matter of inclination and comfort than necessity. The invalidism was of a mild character, and the patients could, and did, attend to their own wants, getting out of bed actively enough when they had occasion to do so. Frequently they were not found in bed, but up and dressed, sitting moodily in a chair, or moping about the house in a restless, aimless kind of way. Their mental condition was usually quite clear. They frequently had no definite symptoms, showing little beyond slight elevation of the temperature, with corresponding increase in the frequency of the pulse, and perhaps a coated tongue, anorexia, constipation, etc., such as might attend the onset of many febrile illnesses. Consequently it sometimes happened that judgment on such cases had to be suspended for a time, but it was usually not long before their true nature was revealed by the appearance of a bubo, or the accession of severely prostrating developments. As an illustration of the class of case here referred to I recall the instance of a clerk who went to business one morning, being, as far as he knew, in his usual health. He had an attack of colic and vomiting during the day, and went home early. He attended his office next morning, and although seedy, remained there all day. Next morning he went to work again, but as he looked ill and complained of weariness, headache, and aching of the body and limbs, he was allowed to go home. It was next day—the fourth of his illness, that I was asked to see him by his private medical attendant. I found him up and

dressed, wandering about his house, and looking, as he expressed it, "a bit knocked out." He had some pallor, a pinched expression, walked slowly, and let himself down into his chair in a way suggesting feebleness of old age. The wife said he had been "talking a lot of nonsense," but he spoke to me intelligently, and knowing my name exhibited considerable curiosity as to my opinion of him. He was also alert enough to refrain from mentioning a swelling under his arm, where I subsequently found a bubo as big as a walnut, and surrounded by diffuse œdema. He went to the Quarantine Hospital in the afternoon, and died three days afterwards.

As in this patient, so in others of the same class, there was no real clouding of the intellect. They were sometimes irritable, or peevish, and resented interference, but quite alive to the objects of our visits, and perfectly prepared to mislead us if they could, as to the real nature of their illness. For as the epidemic progressed we became known as the plague inspectors, and our clinical attentions carried with them the prospect of incarceration at the Quarantine Station. This was not always conducive to cordiality of reception, nor to that perfect confidence which should exist between doctor and patient. It was particularly in the matter of buboes that fertility of explanation was most manifested. They were ascribed to what was commonly called, "barking" of the skin, to scratches with dirty metal, to cuts, or abrasions, to anything, in fact, that would tend to divert suspicion from their real cause.

On the other hand there were many patients, representing the mildest type of the disease, who, because they had a bubo or some other symptoms described in that morning's paper, voluntarily went to the hospitals, or came to the offices of the Department of Public Health, in order to confirm or dissipate their own impression that they were attacked by plague. These people were often worried by the anxiety of doubt, and our diagnosis, whichever way it went, was usually a great relief to them. It is not to be supposed that those who really had plague represented true ambulant cases; they usually became very ill later on and some of them died. They are mentioned as showing that there is not inevitably any marked reduction of strength at a time when the case nevertheless can be clearly recognised as plague. It may indeed be asserted that in a few cases there was never anything approaching serious debility throughout the whole period of illness.

I may mention finally upon this point that the condition presented at any particular time could rarely be relied upon as a guide to the future progress of the illness. At nearly all stages up to established convalescence there was a liability to sudden

and unexpected changes of serious or even fatal consequence. As will be explained presently the patients were always conveyed in charge of trained attendants from their homes to the Quarantine Hospital, first by ambulance and then by steam launches. There was one man transferred from his house to the ambulance, and from the ambulance to launch upon a stretcher, who felt so little ill that he refused to obey the nurse's order to remain lying down. He sat up during the half hour's journey down the harbour and appeared to be enjoying the trip. As the launch approached the landing jetty, this man stood up, waved his arm, fell back, and died almost immediately afterwards. No doubt his death was due to failure of the heart consequent on the degeneration of its fibres that occurs in plague. It was particularly in patients apparently mildly ill or progressing favourably that this untoward complication was apt to occur with startling abruptness, and we learned to regard the issue of any case as uncertain until all constitutional symptoms had quite passed away.

In the foregoing paragraphs I have dealt with the question of the clinical recognition of plague from the health officer's point of view, devoting attention to the subsequent course of the illness only in so far as was desirable in order to complete the illustrations. The endeavour has been to represent, so to speak, the various grades of illness in which our various patients were discovered when first coming under our notice. In doing this I have ventured to offer illustrations not only of cases of typical or average severity, but also of others expressive of variations up to the extremes in both directions. The general outcome is to suggest that plague can be recognised if there be a characteristic bubo, and reasonably suspected on evidence of a person having been suddenly and violently stricken down with illness of a severely toxic nature. Where neither of these conditions obtain, a decision must perforce be withheld pending further investigation and developments. I would submit, however, that the effort to present a comprehensive view has involved the elimination of minor details to which one or other clinician has attached considerable diagnostic significance. But the value of these is to be appreciated only or mainly by those who have had practical acquaintance with plague. Their accurate interpretation depends on what it has become fashionable to call personal equation; they constitute the bright spots of that kind of experience that has been compared to the stern lights of a ship, illuminating only the track that has been traversed. However valuable to their possessor they can rarely be conveyed to others, and therefore I have abandoned the idea of attempting to delineate such delicate indices.

The means of obtaining a bacteriological diagnosis.—The third practical point in the recognition of plague selected for consideration concerns the means used to obtain a bacteriological examination. The arrangements made at Sydney were, that on report from a private practitioner of a case of plague, or one that might be such, it was immediately visited by a member of the official staff of the Department of Public Health. The visiting medical officers carried with them in their bags, amongst other things, a sterilised hypodermic syringe fitted with platino-iridium needles, a platinum wire loop in a glass handle, two culture-tubes, one agar and one serum, a metal box of sterilised cotton wool, a small bottle of lysol, a small wide-mouthed stout glass bottle, a spirit lamp, and about a dozen cover-glasses. These articles were all prepared beforehand in the laboratory of the Department, and as used were replaced by a fresh set. With this apparatus they were always able to obtain, in doubtful cases, samples of bubo fluid, blood, or sputum, in a way that gave a reasonable prospect of success in the subsequent examination.

We never attempted to incise a bubo, save in the hospital, on account of suppuration; the fluid for diagnostic examination being always obtained by puncture and aspiration with the needles and syringe, after preliminary cleansing of the skin. Any fluid obtained was conveyed to the laboratory in the barrel of the syringe, and there taken from it to inoculate culture tubes and a guinea-pig, and to make cover-glass preparations. Sputum was taken in the sterilised wide-mouthed bottle, and at the laboratory treated in the same way as bubo fluid. With blood, the culture tubes were inoculated, and cover-glass smears prepared at the bedside of the patient.

Puncture of a bubo did not always yield fluid for examination. In the early stage success depended on puncture of the swollen gland itself, which had to be defined and steadied between the thumb and fingers of the left hand whilst performing the small operation. In the later stages this was less important, as the exudation round the gland contained abundance of plague bacilli. The amount of fluid obtained was rarely more than a few drops, and in some instances, when none appeared in the barrel of the syringe, one could still obtain enough from the channel of the needle. It was also possible, in some cases, to express a drop or two of fluid out through the needle track by gently squeezing the bubo, and with the small quantity so obtained to make cultures and smear preparations as in the case of blood. The fluid obtained at these examinations was seldom purulent, but usually a greyish coloured mixture of lymph and blood, containing innumerable plague bacilli. Our

experience was similar to that of other observers, in that bacilli were relatively scanty in pus from suppurating buboes. Specimens of blood rarely showed plague bacilli, save when taken from patients who died within twenty-four or forty-eight hours afterwards, and even in these the micro-organisms were usually few, and discovered only after long search. The cultures from blood were more useful so far as recovery of bacilli was concerned, but the patient was generally dead by the time one could examine and pronounce upon the growth. It afforded confirmatory rather than diagnostic assistance, and this applies also to guinea-pigs inoculated from the small clots often found on the culture tubes inoculated with the blood. I have nothing special to remark with regard to sputum, as very few samples came under my notice.

I need not in this place enter upon any detailed account of the laboratory operations and their results. Our observations were in accord with the authoritative descriptions, and are fully recorded in the official report. Suffice it to say, therefore, that they usually afforded valuable assistance, but occasionally failed to throw any light upon the case, owing to practical difficulties in the way of obtaining suitable specimens. A bacteriological diagnosis was specially serviceable to us at the beginning, to determine individual cases, and establish the existence of the epidemic. Later on the cases were clinically diagnosed with increased confidence, and a bacteriological examination required only in doubtful or important instances. Our experience of it was that with care it did not mislead, but we had to recognise limitations to its practical utility.

(II.) THE MODE OF DISSEMINATION.

With reference to the epidemiological aspect I can only in this place present a brief summary of the evidence obtained concerning the origin and mode of spread of the plague amongst us at Sydney, and again refer you to the official report for details.

Our first patient fell sick on January 19th, 1900; the second about four weeks later; the third about four days after the second; and then followed the rapid succession of cases comprising the epidemic. We ascertained no reason to doubt that the case reported in January was actually the first that occurred in Sydney. Examination of the monthly mortality statistics for January, 1900, December and November, 1899, showed no essential differences between them and the data for corresponding months of previous years. Enquiries at the hospitals, and of medical men with large practices afforded no indication of

the existence of any excess of patients with buboes (ambulant cases) during the months in question. I have no doubt that any such circumstance would have been noticed, since medical men were fully alive to the possibility of meeting with plague, partly on account of the prevalence of that disease at Noumea (four days journey by steamer) and partly because of the comment aroused amongst them by the reported occurrence of a case at Adelaide. But neither at the time nor since has any member of the profession asserted his cognisance of a previous case in Sydney, and we did not succeed in gleaning even a suspicion that any person sick with plague had come to the Colony from abroad. Consequently, although experiences elsewhere have been such as to induce caution in expressing assurance as to the primary incidence, all the evidence we could gather was uncompromisingly to the effect that the first person to acquire plague was the man reported to the Department of Public Health in January.

The fact that this first patient really had plague was vouched for by clinical and bacteriological evidence of such a convincing description as to place the diagnosis beyond doubt. But we were quite at a loss as to the manner in which he had become infected. He had never been away from the Colony, and careful investigation failed to reveal any receipt or handling of possibly contaminated articles. The one suggestive fact in this respect was that he was a carter in the employ of a shipping firm, and his business took him to certain wharves which were the scene of the next incident in the epidemic, and in other respects a very important feature of it.

Immediately upon the occurrence of the first case a proclamation was issued, in the official Gazette, in the public press, and by printed placards posted up in all parts of the city, requesting information with regard to sickness or unusual mortality amongst rats. It was not many days before we were advised by a customs officer that the rats were dying in great numbers upon one of the wharves, and on the afternoon of the same day on which this report was received we obtained fifteen rats from the wharf—some dead, some sick, and some apparently healthy. *Post-mortem* and bacteriological examinations showed that no less than seven of them had plague. We immediately set men to work to trap and kill the rats, and many lots of them were examined in the laboratory with sometimes positive, sometimes negative results. Enquiries made of government officials employed about the wharves—customs officers, fruit and grain inspectors and others, elicited the information that the dead bodies of rats to an unusual amount had been noticed for some weeks before our attention was

called to the matter. The epizootic amongst the rats was thus indicated to have commenced at a date prior to the occurrence of the first case in a human being. As already stated this patient had been upon some of the wharves in the vicinity of that upon which the plague rats were discovered.

The next episode was the death from plague—bacteriologically confirmed—of a man who resided immediately opposite this very wharf, whilst the third patient was a clerk employed actually upon it. The series of cases which next followed, with a remarkable exception to be mentioned directly, were all in persons who either lived in, or frequented, the vicinity of the wharf in question. The exception referred to was that of a family living miles away from the wharf, and in which, within two or three days of one another, the father and three children fell sick with plague. They were very poor people, and occupied a dirty dwelling swarming with vermin, situated adjacent to the municipal garbage tip. The children were said to be in the habit of playing upon the tip, and the other members of the family were also believed to have dealings with it. At this tip there was deposited the rubbish collected, amongst other places, at the wharf already mentioned, and the presumption is that the infection of this particular family was acquired from some article, rat, or vermin carried thence by the scavenger's carts. So that these cases also were associable with the wharf and its plague rats, and its locality remained for a period of several weeks the only one from which infection appeared to be derived.

Of course the people becoming infected in this area fell sick and were found by us in various other parts of the city and suburbs, but it was some time before what may be called indigenous cases arose in any other place. There was a spread continuously along the water front, and for some little distance inland into the city; but it was not till later that cases appeared in persons residing outside the area of connected extension, and having no relationship with it. Such cases occurred in women and children, or in men who had not been away from their district within a time covered by the period of incubation of plague. These separate areas in which plague thus appeared to obtain, as it were, an indigenous foothold, were not specially those at which persons infected at the primary (wharf) focus had fallen sick. Very often the indigenous cases were the first or only ones that occurred in them. The one fact indicative of the possible mode of importation of plague into such areas was that in nearly every one of them we sooner or later captured rats, which on examination at the laboratory were found to be infected with plague. They were

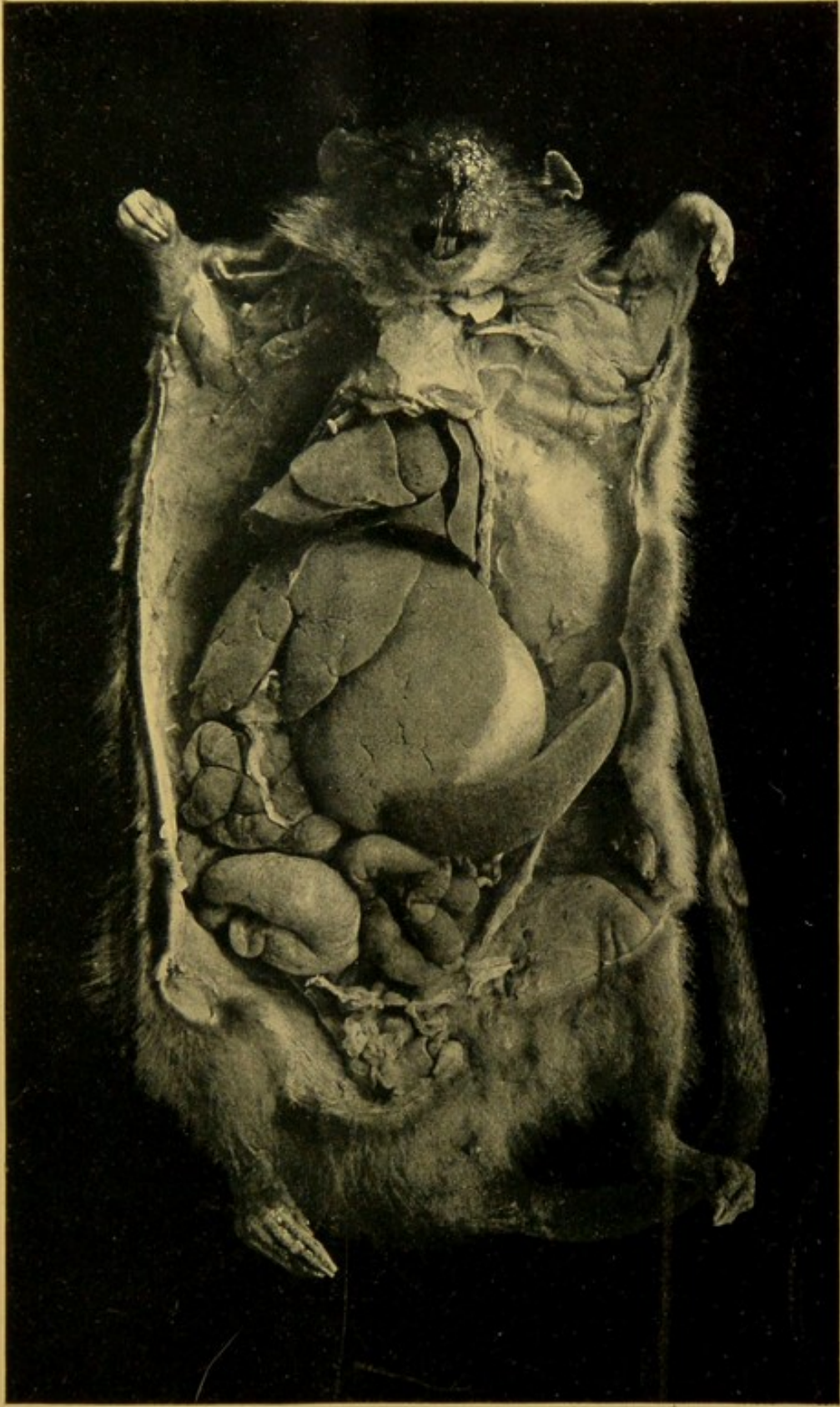


PLATE 1.

PLAGUE RAT NATURALLY INFECTED, SHOWING GREAT ENLARGEMENT OF THE
SPLEEN AND LIVER.







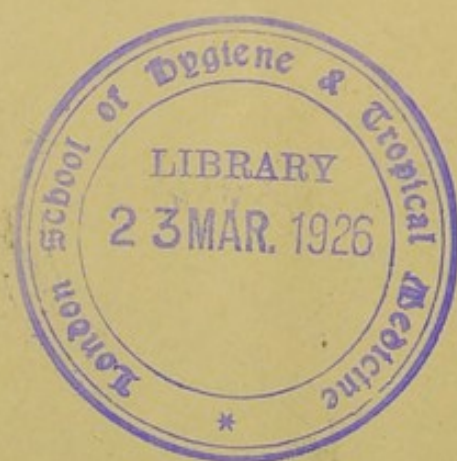
PLATE 2.

GUINEA PIG DEAD AFTER INOCULATION WITH PLAGUE (PARTLY DISSECTED, LIVER AND ALIMENTARY TRACT REMOVED) SHOWING MILKY NECROTIC SPOTS IN SPLEEN AND HÆMORRHAGES IN LUNGS AND HEART



PLATE 3.

GUINEA PIG DEAD AFTER INOCULATION, DISSECTED TO SHOW SWELLING OF THE SUPRARENAL BODY AND HÆMORRHAGE IN KIDNEYS, AND BUBO IN RIGHT GROIN.





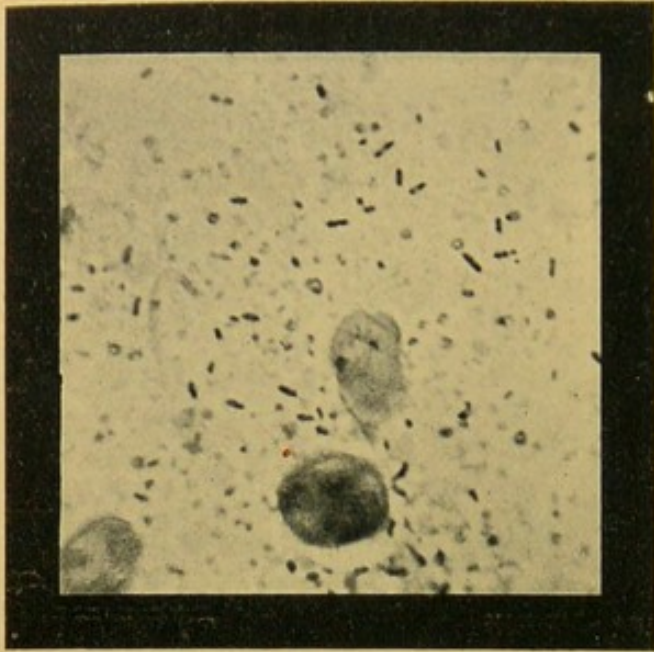


Fig. 4.
PLAGUE BACILLI IN FLUID FROM BUBO.

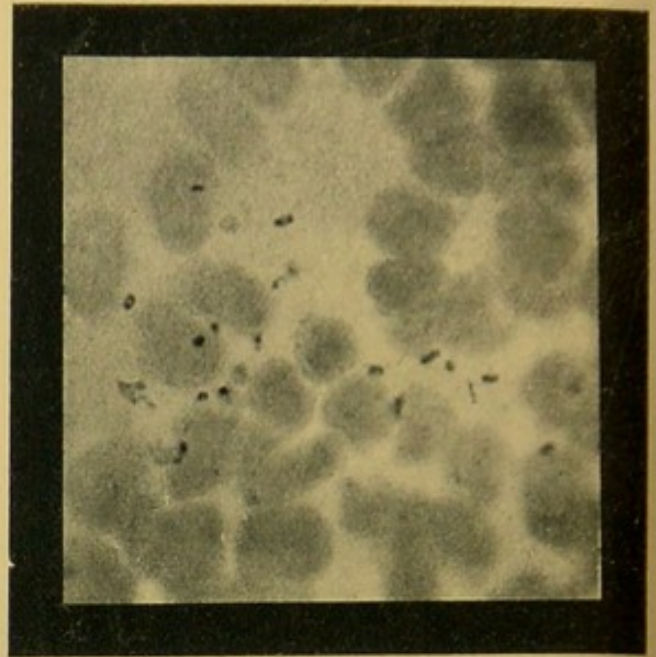


Fig 5.
PLAGUE BACILLI IN FLUID FROM A CARBUNCLE.

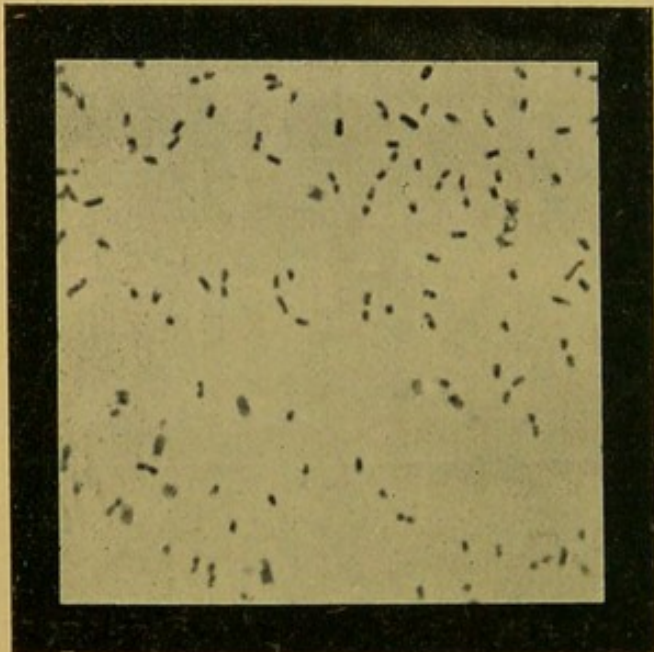


Fig. 6.
PLAGUE BACILLI FROM AN AGAR CULTURE.

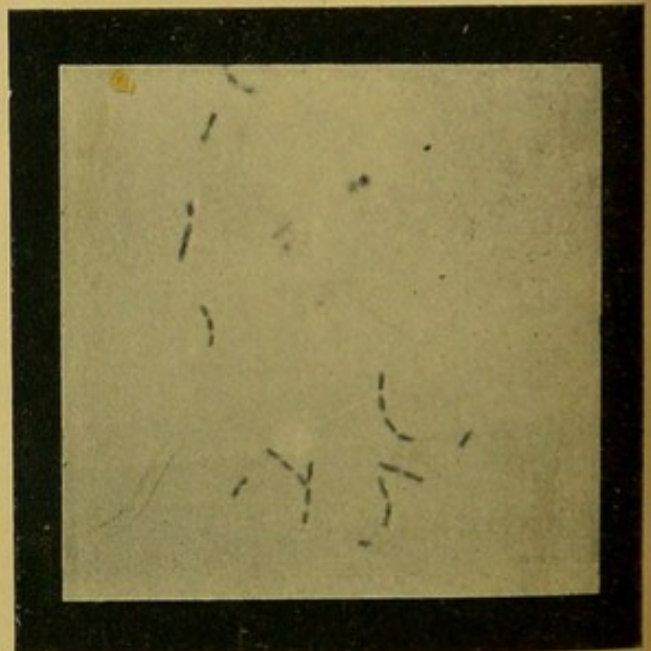


Fig. 7.
PLAGUE BACILLI FROM A BROTH CULTURE.

taken not only from the locality, but in a few instances from the actual houses in which plague occurred. In this and in other ways it became impressed upon us that the incidence upon human beings was practically always associated with disease of the rats. We were confronted, as others have been, with the triangular problem in the transference of plague which this dual existence of the disease involves, viz., infection from animal to animal of the same species; infection from man to rat; and infection from rat to man.

The one clear fact in our epidemic was that human beings were not becoming infected directly from one another. We had occasionally two or three cases in the one household, or amongst the employees of a single business firm, but almost invariably the attacks were either practically simultaneous or separated by such an interval as excluded the possibility of infection by direct contact. In most instances, however, there was but one case in a family or staff, and there was an entire lack of immediate relationship between it and any other of the epidemic. On the one hand the patient had not seen, nor been near, and often did not know any infected or possibly infected person, and on the other no secondary cases arose in his household or elsewhere as the result of his own illness. It very often happened that patients fell sick in remote suburbs or in country towns to which they had gone by railway; circumstances that could not fail to result in the detection of any secondary case arising from them. But neither in these, nor in any other instances, was there the least evidence that one person had acted as the source of infection for another. There was no ground for even a suspicion that our epidemic was being maintained by any process of direct contagion between man and man.

We did not observe any case in which the infection could be ascribed to handling or receipt of contaminated articles. The only evidence bearing upon this point was that some three or four, out of as many thousands of the men engaged in cleaning up the infected areas, acquired plague. They were working in different places, handling different materials, and fell sick at different times, so that they did not serve to indicate any particular articles as infectious. Moreover, as they were employed in places harbouring infected rats, not necessarily those contaminated by human beings, they were on the same footing as other patients not engaged in the cleaning operations. We have, therefore, no evidence that infection could be acquired by any process of indirect contagion. It thus came about that the disease was not observed to spread either directly or indirectly from man to man.

With regard to the natural means by which the disease was

kept going amongst the rats, we have no very definite evidence to offer. Experimentally, however, they succumbed to inoculation, and to pricks and scratches with infected instruments, such as might be received from teeth or claws in quarrels with fellow rodents. Encounters of this kind were frequent amongst rats kept in the laboratory cages, and sometimes culminated in one of the party being reduced to a few claws and a backbone. In captured rats we often found bites on the ears and nose, and if these had been received during an argument over the body of an infected confrere, they would no doubt have been the means of introducing plague into their recipients. But from our examinations this did not appear to be a common mode of infection, since we never found true buboes in captured plague rats. There is a possible fallacy in this inference, since plague is apt to assume a septicæmic form in rats, and hence there would not be a bubo. But swelling of the nearest lymphatic glands, accompanied by hæmorrhagic exudation, was usually produced by experimental inoculation, and consequently one would expect it to have been seen if the natural infection was acquired in a similar way. We found that rats could be infected by feeding, the experimental animals being kept in glass jars by themselves, and given soft material, bread or biscuit soaked in cultures of plague bacilli, or the spleen and liver of rats or guinea-pigs recently dead from plague. Feeding with the organs was much more successful than feeding upon cultures, the latter sometimes failing to produce infection. In one instance we found a large mesenteric gland in a captured rat, and in one of the experimental rats the whole group was swollen, matted together and embedded in hæmorrhagic exudation, indicating that infection had been acquired through the gastro-intestinal tract. Owing to their cannibalistic proclivities, possible injuries from bones, and the probability that a comparatively helpless sick animal would be regarded a fair object for attack, feeding may be supposed to contribute something towards the maintenance of epizootic plague in rats. We never succeeded in producing plague in rats or other experimental animals by placing them in the uncleaned cages and jars in which animals were dying or had died from plague. I may here remark that our laboratory operations were never attended by accidental conveyance of infection amongst the animals more or less closely associated in the various experimental investigations conducted by us. We risked upon two occasions the scattering of numerous fleas over an infected and sick rat, to test whether these vermin would convey the disease to a healthy one kept in the same cage, but separated by a double wire screen with wide meshes,

as mentioned by Simond. The experiment was negative on both occasions, and I am glad to say that we had no further acquaintance with the particular fleas used in the experiment. We did succeed in setting up infection by means of an emulsion of fleas taken from a very sick rat captured at a hotel from which we had just taken a girl suffering from plague. The bacilli were detected by microscopic examination of the emulsion, and injection of a few drops of this fluid into a guinea-pig produced plague fatal in the usual time; the animal showing the usual *post mortem* appearances including a bubo; and its viscera yielding micro-organisms, with subcultures of which we were able to produce plague in other animals. We are therefore able to make this small contribution in favour of the statement that plague bacilli may be found in or on fleas, and such vermin may thus be the means of disseminating the disease amongst rats. Briefly summarised, our experiments seemed to indicate that the disease might spread from rat to rat by inoculation through wounds from infected teeth or claws, or sharp points of bone in their food, or by vermin, and by feeding upon the viscera of infected animals. It appeared also that feeding upon infected food of other kinds, such as biscuit or bread deliberately soaked in culture would occasionally result in infection, but usually did not, and no positive result was obtained by feeding upon the food merely soiled by a sick animal.

Our epidemic does not furnish any clear evidence on the question of the transference of plague from man to rat. That the excretions of plague patients contain bacilli, and that rats feed upon such infected excreta in the sewers, suggested itself to us as a possible mode of such conveyance. To a certain degree the extension of the primary focus was along rather than across main sewer lines, and the secondary indigenous foci occurred on small reticulations connected with the larger ducts, suggesting that rats may have picked up the infection from material carried along the sewer. But this did not cover all cases, and the time relationship was not in keeping with such a theory. It appeared rather more probable that the sewers constituted highways along which infected rats migrated, and thus disseminated the disease from the primary focus. Meanwhile I need only say that we did not observe any clear facts indicating a spread from man to rat.

The last point in the problem under consideration was transference from rat to man. I have already stated that at the wharf in the neighbourhood of which the bulk of our early cases occurred, mortality amongst rats preceded the incidence of plague upon man; and that in other indigenous centres

plague rats were almost invariably discovered. Many of our patients had actually handled dead rats, others had seen them about their houses and premises, or what seemed to impress them much more strongly, they had smelt them. These facts, considered in conjunction with the entire absence of immediate or mediate contagion, induced us to believe that rats were the sources of infection for human beings. As regards the exact manner in which the microbes obtained entrance into the bodies of our patients, the evidence was to the same effect as that obtained elsewhere, namely, that they were infected by inoculation. The preponderance of femoral buboes indicated that the actual site of inoculation was usually somewhere on the lower limbs, but the suggestion of oriental epidemiologists that infection occurs with dust entering small unnoticed wounds on the bare feet did not apply to our cases, as our people all wear boots. We never had any patient who could be supposed to have received his infection through wounds—cuts or abrasions. We had therefore to fall back upon the theory promulgated by Simond and others, that fleas were responsible for the actual transference of the causal bacteria. We could nearly always find fleas upon the rats forwarded for examination. This was so commonly the case that as a measure of self-protection we adopted the practice of using chloroform to stupefy the fleas, and then burnt the fur off the rats, and so destroyed the fleas before allowing the cages to be brought into the laboratory. The number of fleas upon rats specially examined was very variable, but sometimes there were a great many upon sick rats. We had no difficulty in obtaining a dozen fleas from such a rat for the purpose of making the emulsion already mentioned. I am not prepared with the names of the species of fleas found on rats, as I knew no one in our Colony who could advise me upon that point. But some of the creatures were large, like those found on dogs; and others were small, showing on comparison no difference that I could detect from fleas obtained from human beings. It has been asserted by Galli-Valerio that fleas from rats will not bite mankind, but this has been disputed by other observers, and I can at least vouch for the fact that rat fleas promptly make for one's hands when a rat is manipulated. I need scarcely say that we did not wait for a practical demonstration as to whether they would bite. For my own part, I am inclined to believe that although fleas have a predilection for particular species of animals, they will go upon others and often sample them by a bite or two, before returning to the host best fulfilling their epicurean inclinations. It is said, and appears probable, that the fleas will remain upon rats until their par-

ticular host dies. The circulation then ceasing and the body becoming cold, the fleas are compelled to search elsewhere for their accustomed pabulum. They may probably seek another rat, but on their journey invade some other animal, perhaps man. On this point I may mention that we were informed that at the time the rats were dying in large numbers upon the wharf to which attention was called above, the fleas there were so numerous that the labourers tied strings round the bottoms of their trousers to protect themselves against the onslaughts of the vermin. Some of our patients recollected being bitten by fleas at a date consonant with an incubation period of three to five days. The majority had no such remembrance, but the social status and domestic habits of most of them were not such as to invest a little incident of that kind with remarkable novelty. They were often oblivious of having been bitten when their skin showed abundant evidence of it. In several instances we found the tiny blisters or phlyctenules mentioned by Simond and others as marking the actual site of inoculation by fleas, and in a smear preparation from one such case, we found micro-organisms having the microscopical characters of plague bacilli. On the whole, therefore, we became possessed of some facts which seemed to show that Simond's contention was not altogether hypothetical.

In view of all the evidence,—positive as regards rats and fleas, and negative as regards other agencies,—we were compelled to believe that our people were being infected from plague rats, probably through the intermediation of plague fleas or similar vermin. The liability of cats to plague, as mentioned by Lorans of Mauritius, and confirmed by the instance at Sydney, may perhaps be regarded as an additional condemnation of the rat, in view of the association between the two species of animals.

We did not succeed in discovering how the rats first became affected. The Port of Sydney is in frequent communication with infected places in China and India, and also with the Sandwich Islands and Noumea, where plague was prevalent at the time of our outbreak. But there was no evidence that any contaminated article or plague rats reached our shores from any of these places. The only fact bearing upon the point is that amongst the rats forwarded to the laboratory for examination there was a large rough black-coated rat, different from the local rats and said to be an Indian species. This particular specimen was perfectly healthy, but if it really be a foreigner, its presence in Sydney paves the way to the assumption that infected rats may have reached us by some similar means. Unfortunately, up to the present there has been no opportunity

of obtaining an authoritative opinion as to the species of rats already established in Australia, so that no special significance can be attached to the incident just mentioned.

III.—APPLICATION OF PREVENTIVE MEASURES.

It is a curious fact, mentioned by Hirsch as regards former epidemics, and by several modern writers with respect to the present pandemic, that there has often been exhibited a tendency to deny the existence of plague on its first appearance at any particular place. It was not surprising therefore to find that the attitude assumed by our own community was at first one of manifest incredulity. The press, the public, and the medical profession, were strongly disinclined to accept our pronouncement on the first case. The bolder spirits amongst them did not hesitate to accuse the authorities of error without, however, taking the trouble to ascertain the facts for themselves. Fortunately the evidence with regard to that case was so clear and convincing that the officials of the Department of Public Health were able to maintain an unwavering adherence to their diagnosis, and to meet the storm of ridicule by firm insistence on the application of the requisite preventive measures. The discovery of the plague-stricken rats was the incentive for the organisation of a special service to cope with the epidemic thus suggested as imminent, but owing to the solidity of the passive resistance, our efforts in this direction made but slow progress at this time. For a period of about six weeks we were exposed on the one hand to adverse public criticism, and on the other to hesitancy in the acceptance of our recommendations. This undesirable condition of affairs underwent an abrupt change when six cases occurred, and terminated fatally one after the other in rapid succession. The former disbelief gave place to excited appeals for guidance. There was no longer any question of excessive zeal on our part, on the contrary we were overwhelmed by hysterical advice as to what ought to be done. With the melancholy satisfaction derivable from this long delayed removal of opposition, we set ourselves to the arduous task imposed upon us, and proceeded to a more elaborate campaign against the pestilence.

Briefly stated our procedure was as follows: On receipt of a report from a practitioner of a case of manifest or suspected plague the patient was immediately visited by a medical officer of the Department. If the case proved to be plague, the inspector informed the sergeant in charge at the nearest police station, who thereupon dispatched a constable to take charge of

the house and prevent any person from leaving it. The medical officer also telephoned from the police station to the Department, and by this means a nurse and ambulance were sent to remove the patient, and a waggonette for other persons or contacts. The patient was conveyed to the Quarantine Hospital, and the contacts to the observation enclosure within the Quarantine Station. Sometimes the removal was suspended for twenty-four hours or so pending the result of bacteriological examination of specimens taken to the laboratory of the Department by the medical officer. After removal of its occupant the house was locked up and left in charge of the police, who admitted the disinfectors and afterwards looked after it till the return of the contacts. Business premises were not closed unless at least two employees had become plague-stricken. It was then treated in the same way as a private house, but otherwise disinfection was carried on, one floor at a time, whilst business remained in progress. When an infected area became defined, a proclamation was issued giving twenty-four hours notice of suspension of business within certain prescribed limits. After that time it was surrounded by a cordon of police, and a gang of men turned in to clean up the whole area. Meanwhile efforts were made to destroy rats, by the employment of professional rat-catchers and by stimulating private enterprise to that end. Finally we carried out public inoculation with Haffkine's prophylactic obtained from Bombay. These various operations were kept going for a period of seven months. Their administration involved no slight effort on the part of the authorities, and their execution necessitated the organisation of special staffs for the different branches of the work.

Under ordinary circumstances the medical staff of the Department of Public Health were two (now three) specially qualified hygienists; but there were in addition two Medical Officers of Health, more or less closely in touch with the central office. On the outbreak of plague the medical staff was increased to seven members; two stationed at the hospital, three engaged in regular visitation of the patients, and two mainly occupied in administrative and other general matters connected with the epidemic. From time to time we had the assistance of medical visitors from other colonies who came to gain experience, and of many medical men practising in Sydney, but these were chiefly employed in connection with the inoculation of Haffkine's fluid. I must here remark that, once convinced of the reality of the plague, the medical profession generally gave courteous and loyal support to the Department.

The discovery of plague rats was accepted in the microbiological laboratory as a signal to clear the decks for action,

and when the demand came for bacteriological diagnoses and experimental observations the staff were ready and prepared to meet it. The work done in this branch of the Department was so exacting that for a period of three or four months the assistants were in the laboratory every day—Sundays, highdays and holidays included—from 8 o'clock in the morning till nearly midnight.

The general office was inundated with letters and besieged by callers, requesting advice, assistance, employment, concessions, or interviews; instituting protests or claims for compensation; seeking information concerning the sick or their effects; propounding schemes for the eradication of the plague or the treatment of the sick; and otherwise materially augmenting what may be termed the legitimate business connected with the epidemic. To meet the stupendous increase of work additions had to be made to the clerical staff in nearly every branch of the office.

The preventive measures included the removal of both patients and contacts, an action which, in the absence of statutory sanction, had to be carried out under Executive authority. For although there was ample power under the Quarantine Act and regulations to prevent a person with plague from entering the colony by sea, there was none to enable us to deal with a case arising within our own boundaries. The Public Health Act covers at present only notification, and it was our hope that in time this would furnish the means of educating the people up to the point of accepting an Isolation Act. The consequence was that we had no legal right to remove the patient, but the emergency was held to justify this course, subject to subsequent confirmation by the Executive. As a matter of fact there was never any real difficulty about the patient. The community came quite solidly to the view that he was better isolated, and resistance, though occasionally threatened, was never practised. But it was otherwise with regard to contacts. They, being quite well, naturally enough objected to being taken from their homes, and the fact that those removed invariably remained unaffected, was quickly brought forward as an argument for the abolition of our practice. For our own part we recognised that there was room for debate upon this question, and were prepared to substitute isolation within their own houses, and daily visitation for a period, in lieu of their removal. But we asked for discretionary powers in this respect, pointing out that a large isolated house was less dangerous and more easily disinfected than the small crowded dwellings occupied by the poor. This proposal was rejected as a matter of political expediency, so we had to accept

the next best thing, and remove all domiciliary contacts indiscriminately. This procedure worked smoothly enough when it concerned five or six persons in a private house, but the evacuation of hotels and large boarding-houses, with forty or fifty contacts, at a moment's notice was not accomplished without considerable strain of the transport and commissariat. However, it was done as a matter of course, and as the Quarantine Station at Sydney is a delightful and picturesque place, the procedure eventually came to be regarded as having provided a very enjoyable excursion for many deserving citizens.

The means of conveyance comprised an ambulance and waggonette service, and a flotilla of steam launches. By the former the patients and contacts were conveyed from their houses to the Quarantine Depôt and Wharf at Sydney, and by the latter they were taken about six miles down the harbour to the Maritime Quarantine Station at North Head. The ambulances and drivers were drafted from the regular staff of the (Government) Coast Hospital at Little Bay near Sydney, and accomodated at the Depôt, where additional quarters and stabling were erected for the purpose. Each ambulance carried a trained nurse and the usual equipment. The steamers comprised the regular service launches and others specially chartered, and were provided with shelters and other arrangements for the welfare of the patients. Although apparently complicated, the arrangement worked quite steadily when once organised.

On arrival at the Quarantine Station the patient was transferred to the permanent hospital buildings situated on a promontory and well isolated, whilst the contacts were conducted to apartments in pavilion houses on what is known as the healthy ground. The general management of the station was under the immediate control of the Superintendent of Quarantine and the permanent officers of his staff, assisted by hands temporarily employed during the epidemic. The resident hospital staff comprised two medical men, a dispenser, and the necessary complement of trained nurses and wardsmen. All the nurses were officers of the Government Coast Hospital or Quarantine Services, who, with the devotion characteristic of members of their profession, spontaneously volunteered for plague duty. In addition to the resident staff the hospital was visited regularly by a senior member of the medical profession, and frequently by the medical officers of the Department of Public Health. Facilities were afforded for medical men to visit the hospital and familiarise themselves with the disease.

The disinfecting staff consisted of gangs of men acting under the guidance of trained quarantine officers; the whole of this business being under the supervision of the Medical Officer of

Health for Sydney. The methods of disinfection practised comprised fumigation with sulphur or formalin; spraying and washing with corrosive sublimate or carbolic acid solution; clearing out and lime whitening of outside premises; steam disinfection of articles exposed to contamination or their destruction by fire when they were not worth preserving; and renovation where such appeared to be necessary. The Public Health Act enabled us to compel owners to repair structural defects, and its stringent application resulted in the institution of new drains and modern sanitary fittings in many places sadly in need of them. As opportunity offered, or could be made, ferry boats and coasting steamers were also dealt with by the staff here under consideration.

The procedure in dealing with proclaimed areas consisted as stated, in a general clean up by large gangs of labourers temporarily employed for the purpose. The number so engaged averaged about 2,000 men, acting under the direction of an experienced contractor, and the Sanitary Inspector of the Department of Public Health and his assistants. In special cases they received the advice or direction of the medical officers, engineers, and architects in the Government service. The object sought was to make a clean sweep of the areas dealt with, removing from them everything that could be regarded as defective from a hygienic point of view. The men entered and cleaned up every street, lane, house and premises; sweeping, repairing, washing and renovating good structures, destroying old or tumbledown premises, clearing out and levelling yards, tearing up old and laying new drains, and generally doing anything of the kind that suggested itself as a means of effecting cleanliness. The combustible rubbish was burnt at bonfires in the streets, and such as could not be so treated was loaded into punts, towed off beyond the harbour, and cast away several miles out at sea. It need scarcely be said that this measure got rid of an enormous amount of rubbish, and effected material improvement in the areas dealt with one after the other, covering in the aggregate a large part of the city. Of course it was not accomplished without imposing individual hardship, but in such instances the sufferers received adequate consideration from the Government. As the cordon of police posted round the area in which cleansing operations were in progress restricted ingress to authorised persons, and incidentally prevented the residents inside from getting out, provision was made for their maintenance at the public expense during the period of their incarceration. The interruption of business was the subject of many protests and claims, but for the most part these received little sympathy from the community, the

general impression being, by that time, that the operations represented salutary efforts towards sanitary reformation. Finally the Government resumed the greater portion of the water front, and intend replacing the present irregular wooden wharves with stone and cement structures, such as will remain cleaner and afford less harbourage for rats.

During the whole time the work of destroying rodents was stimulated by every possible means. Professional rat-catchers, real or alleged, were engaged, poison was supplied free of charge, and private efforts inspired by a reward of first twopence, then sixpence, per head, per rat, delivered at the destructor depôt. Lengths of sewers were blocked up and fumigated with sulphur, the subsequent flushing carrying down numerous carcasses of rats killed by the fumes. The same method was successfully applied to the holds of ships. The use of baits soaked with cultures of bacillus typhi murium (Loeffler) or Denysz' bacillus, did not prove efficacious as rat exterminators. It is true that rats commonly disappeared for a time from places where such baits were laid. But they were not found dead, neither on the surface nor in the runs, and usually reappeared in the course of two or three weeks. On one occasion their apparent depletion at one place was coincident with great numerical increase at another about a mile distant, thus indicating that the rats had not been destroyed but had merely migrated. They afterwards gradually returned to their former haunts. It may also be mentioned that rats became so scarce upon the infected wharves as the epidemic progressed, that it was difficult and sometimes impossible to obtain specimens for examination. This illustration of the fact that these rodents will migrate from places where they are being injured or harassed, suggested the possibility that our efforts might result in the dissemination of plague by scattering infected rats. But upon reflection that sooner or later they would scatter of their own accord, as an instinctive means of ridding themselves of their epizootic, we felt justified in encouraging rather than uselessly trying to check this natural process of elimination of the disease. Besides, from our point of view, every rat killed was one possible source of infection the less, and we accordingly persisted in destroying them by every means in our power. I cannot state the number of rats that met their fate by these efforts, as the returns had not been made up when I left Sydney, and the war against them was still being carried on, but it was said that something like 100,000 had been accounted for up to that date.

The last point to which I will call attention is the public inoculation with Haffkine's prophylactic. As part of our

scheme of preparation for a possible outbreak of plague, we were in possession of a small quantity—about 300 doses—of the prophylactic when the first case occurred. This was used to inoculate the contacts with this case, and the members of the staff of the Department who would have to deal with it, and any others that might occur. At once a cable message was dispatched to India requesting a further supply, and in response to it 25,000 doses reached us about five weeks later. The same cablegram arranged for a regular monthly consignment until further notice. On receipt of the fluid, it was announced that any person could be inoculated free of charge on application at the offices of the Department. There was no great response at first, but as cases of plague continued to crop up, and the public became assured by the experience of friends or prominent persons that inoculation was not synonymous with sudden death, the number of applicants rapidly increased. In the course of a week or two the offices could not hold the crowds that collected. The corridors, staircases, and approaches were crammed with people pushing and struggling to reach the inoculators; damaging each other and smashing the furniture and fittings of the office. Members of the staff who were outside could not get in, and those who were inside could not get out; the conduction of any other business was out of the question. The affair culminated in the office being cleared by the police and the operations being transferred to a large exhibition building, with a police guard to control the assemblage. With the object of securing the utmost protection from the use of the prophylactic it was announced that only persons residing or occupied in the infected areas would be inoculated, and these had to produce written testimony of their eligibility signed by clergymen, employers, or well-known persons. For days the attendance was far greater than could be provided for, although we frequently treated twelve to fifteen hundred persons per day. This exciting episode of the epidemic continued until we had used up two consignments of prophylactic, when delay in the arrival of the third afforded us a much-needed respite. On recommencing operations the epidemic had begun to subside, the panic ceased, and the attendance gradually fell off until we had no further applications.

The actual inoculation was carried out in the following way: The back of the bared upper arm of the patient was washed with lysol solution by an attendant, the inoculating physician injected the fluid subcutaneously, and a second attendant immediately placed a small square of Mead's plaster over the puncture. The two attendants here mentioned were senior medical students, the physician a practitioner in the city whose

temporary services were retained by the Government. There were usually four to six physicians operating at a time. The instruments and prophylactic were in sole charge of the trained laboratory assistants, who attended to the preliminary sterilisation of the apparatus, poured out the fluid and filled the syringes with strict regard to bacteriological cleanliness. The syringes were provided with platino-iridium needles, which were sterilised by heating to redness in the flame of a spirit lamp between each inoculation. To the technical skill and careful observance of instructions is to be attributed the total absence of untoward results in the many thousands of persons inoculated under the exacting conditions above described.

The doses of prophylactic given were in accordance with the directions upon the bottles. The after effects were more or less fever and malaise for twenty-four or forty-eight hours, and a varying degree of cellulitis of the arm enduring for about a week or more. In some cases the febrile attack was sharp, and followed by languor for a few days, but as a rule it did not prevent attention to business. The cellulitis of the arm was sometimes painful for several days, and occasionally a small abscess formed at the site of inoculation. In three such cases that I had an opportunity of examining the small amount of pus was sterile. Beyond what is here mentioned the inoculations gave rise to no trouble, and were not attended by any serious inconvenience to the patients.

It is difficult to pronounce as to the efficacy of the process, in view of the other vigorous measures taken to subdue the epidemic. Some six inoculated persons subsequently acquired plague, but they were all mild cases and recovered. As the proportion of deaths in other persons was one in three, it is to be presumed that the previous inoculation had effected some satisfactory modification. There was in addition the advantage of its moral effect on the populace, who were considerably quietened by the feeling that they had been afforded every possible chance of protection against the disease.

From what has been said it will have been gathered that no efforts known to us were spared in combating the epidemic. The measures taken involved great expense, and an excessively arduous devotion to duty on the part of those charged with their execution. Happily we had the consolation of seeing the epidemic decline and come to an end, which I sincerely trust will prove to be a permanent one. In conclusion, I have to express my appreciation of the honour accorded to me by the Committee's request for a paper, and to thank my audience for the patient hearing of what I feel to be an inadequate recognition of it. I am above all conscious that I have oc-

cupied your attention this evening for a time unduly long, but I hope you will regard this as inseparable from a desire to place at your disposal, as fully as possible, the information acquired by us at Sydney on a subject of mutual interest and importance.

[*This discussion applies to the papers by DR. FRANK TIDSWELL and DR. S. M. KAKA.*]

MR. SHIRLEY MURPHY, the Chairman, said he had pleasure in asking the meeting to accord a cordial vote of thanks to Dr. Tidswell and Dr. Kaka for their interesting papers—papers which were of the greatest importance to them at the present time. We did not know what was before us in England or in London as to plague. Of course we did not anticipate for a moment anything so terrible as what had happened in Karachi, but inasmuch as Glasgow had had the plague to deal with, other parts of this country might have to do the same. They might have to develop an administration to look after it—in fact, the London County Council had already developed an administration to inquire into such cases should they occur. Few persons in London could claim to have had experience of the disease, but all could learn what had happened in India and Australia and other places where the plague had assumed prevalency, and it was very valuable to them to have the information derived from those sources, focussed in such excellent papers. He looked upon the papers as of very considerable value and worthy of detailed study.

DR. FRANKLIN PARSONS (London), in opening the discussion, said the papers to which they had listened had been exceedingly valuable from an administrative point of view, because in dealing with such a disease as the plague they had to consider not only what modern science pointed out as practicable to counteract it, but also what measures popular feeling would accept. It was therefore of very great use to know how plague was looked upon from the point of view of the populace in countries where it had actually occurred, both in India among an alien people, and in Australia among people of like modes of looking at things as ourselves. They had to make people familiar with the mode in which the disease was propagated, with a view to obtain their co-operation. He had heard how when cholera first came into this country it was received with panic, and the doctors were accused of poisoning the patients; but in 1893 when it obtained some foothold in Grimsby there was no panic, because the means of prevention were known and were readily accepted by the people,

with the result that the disease was soon stamped out. From the admirable way in which the Glasgow authorities succeeded in stamping out the plague, he should think that the population of this country was sufficiently educated to accept any measures which might be necessary to counteract the disease should it ever make its appearance. It seemed to him that the great danger lay in the fact that so few people had seen the plague. Probably few of those present, except the two gentlemen who had read papers, had ever seen a case of plague. That was the danger, for experience had shown that when a comparatively unfamiliar disease—such as typhus or small-pox—got ahead, it had always happened because the first case had not been recognised. He noticed that both the readers of papers had laid stress upon the rats as a means of propagating plague, but he believed that the Glasgow authorities could not find any evidence to connect rats with the outbreak that occurred there.

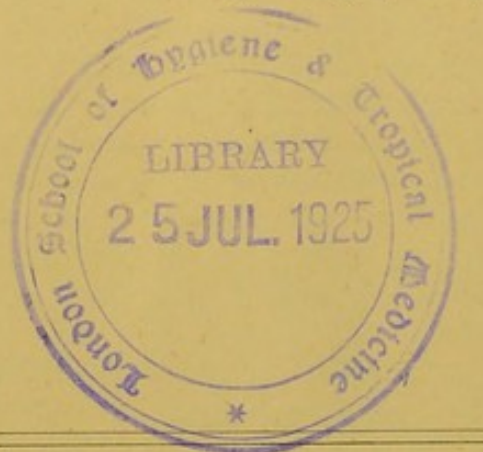
Dr. R. T. HEWLETT (London) said it had fallen to his lot to see one of the six or eight English cases of plague which had occurred, and he also had had the opportunity of examining bacteriologically three of the English cases. Many writers had called attention to the important part which rats played in the propagation of the disease, but he thought Dr. Tidswell's observations on that point were more striking than anything he had ever read. He took it that Dr. Tidswell regarded plague as having been introduced into Sydney by the rats. With regard to rat-fleas, it had of course been suggested that they conveyed the disease to man, but some observers denied that the rat-fleas would bite the human beings. He (Dr. Hewlett) was very interested to hear the amount of inoculation work which was carried out in Sydney, and possibly Dr. Tidswell might be able to give them some idea of the value of those inoculations. He would also be glad to know if the anti-plague serum was used, and if so with what result. He had recently had occasion to inquire into the value of anti-plague serum, and for that purpose had been to the Pasteur Institutes at Paris and at Lille, and at both those institutions the opinion was that there was a great future for the serum. There was one peculiar feature about the plague, and that was the manner in which it rose and disappeared. The history of plague had always shown that apparently the disease had existed in certain localities endemically, and then for some reason or other it began to spread, until at last it was an almost pandemic disease. It appeared in different localities, and without any apparent reason it disappeared, and then the world became again entirely free from plague.

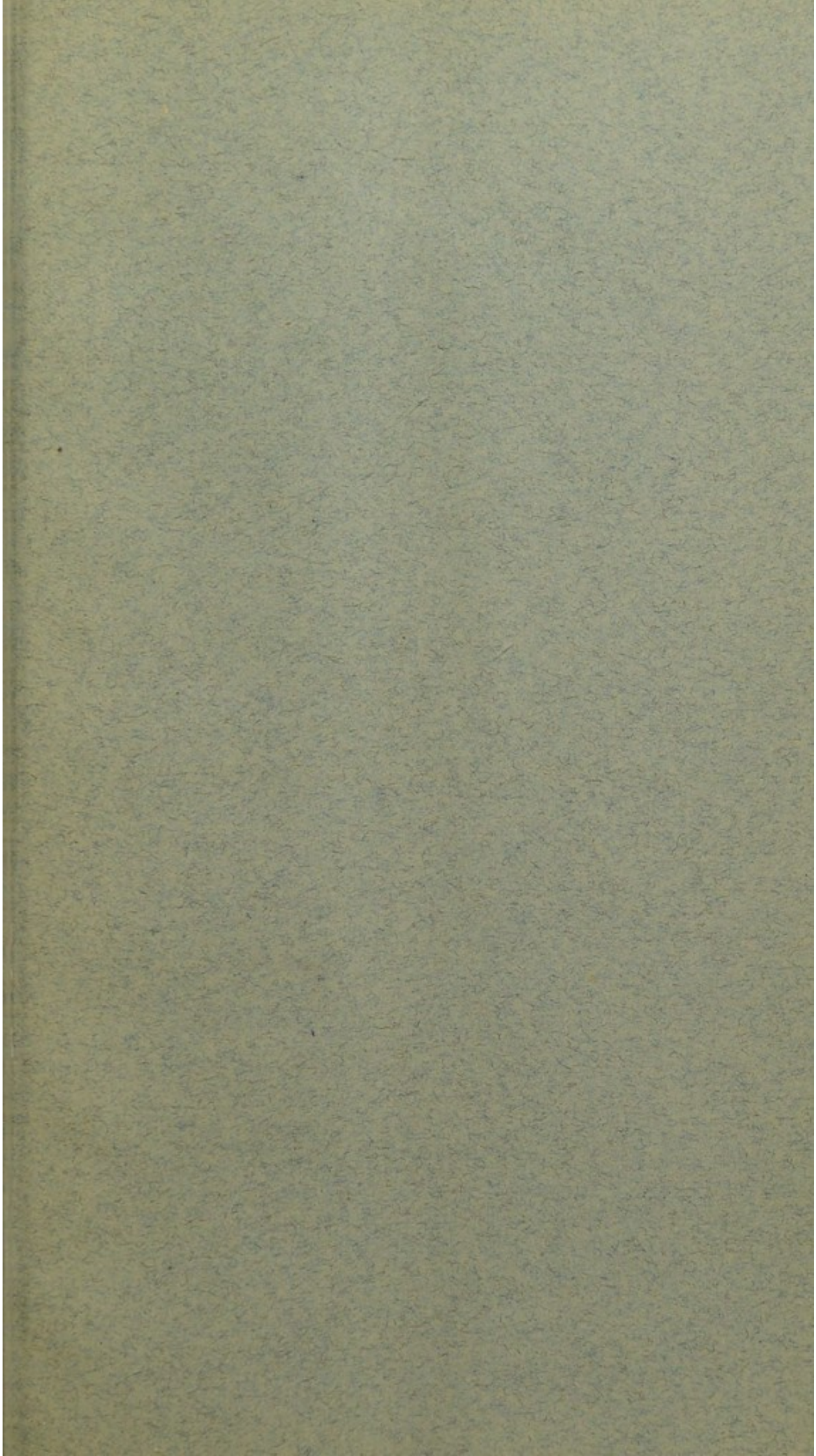
THE CHAIRMAN said he wished it to be distinctly understood that in recent years there had never been plague in London. It had been in the Port of London, but the Port of London extended to the mouth of the river. They had not had a single case of plague in the administrative county of London, although there had been four or five suspicious cases.

Dr. F. TIDSWELL (Sydney), in replying to the observations, said that with respect to the part played by fleas, the work at Sydney had been conducted in view of Simond's researches on that subject. The inoculation of Haffkine's prophylactic had been deliberately restricted to persons exposed in the infected area, with a view to securing its aid in restraining the epidemic. Whether or not it had absolutely protected any individual could not be stated. The half-dozen inoculated persons who subsequently acquired plague had all been mild cases and had all recovered, whereas in the ordinary cases the fatality had been about 33% or 34%. It would thus appear that the prophylactic had been of considerable efficacy in minimising the severity of the disease. The Pasteur Institute serum had been used in the treatment of patients. It had not been attended with such markedly beneficial results as were observed with regard to the curative serum for diphtheria. He would not like to pronounce more definitely upon its efficacy, as the cases treated were comparatively few, and perhaps no rigid inference should be drawn from them.

Dr. S. M. KAKA, referring to the anti-plague serum, said it was used in Karachi, but he could not say that the results obtained were any better than from the ordinary treatment in hospitals. Experiments were still going on at Bombay, but he was afraid, even if the serum was shown to produce beneficial results, it was beyond the reach of the poor on account of its prohibitive cost.

A vote of thanks to Mr. Shirley Murphy for presiding concluded the proceedings.





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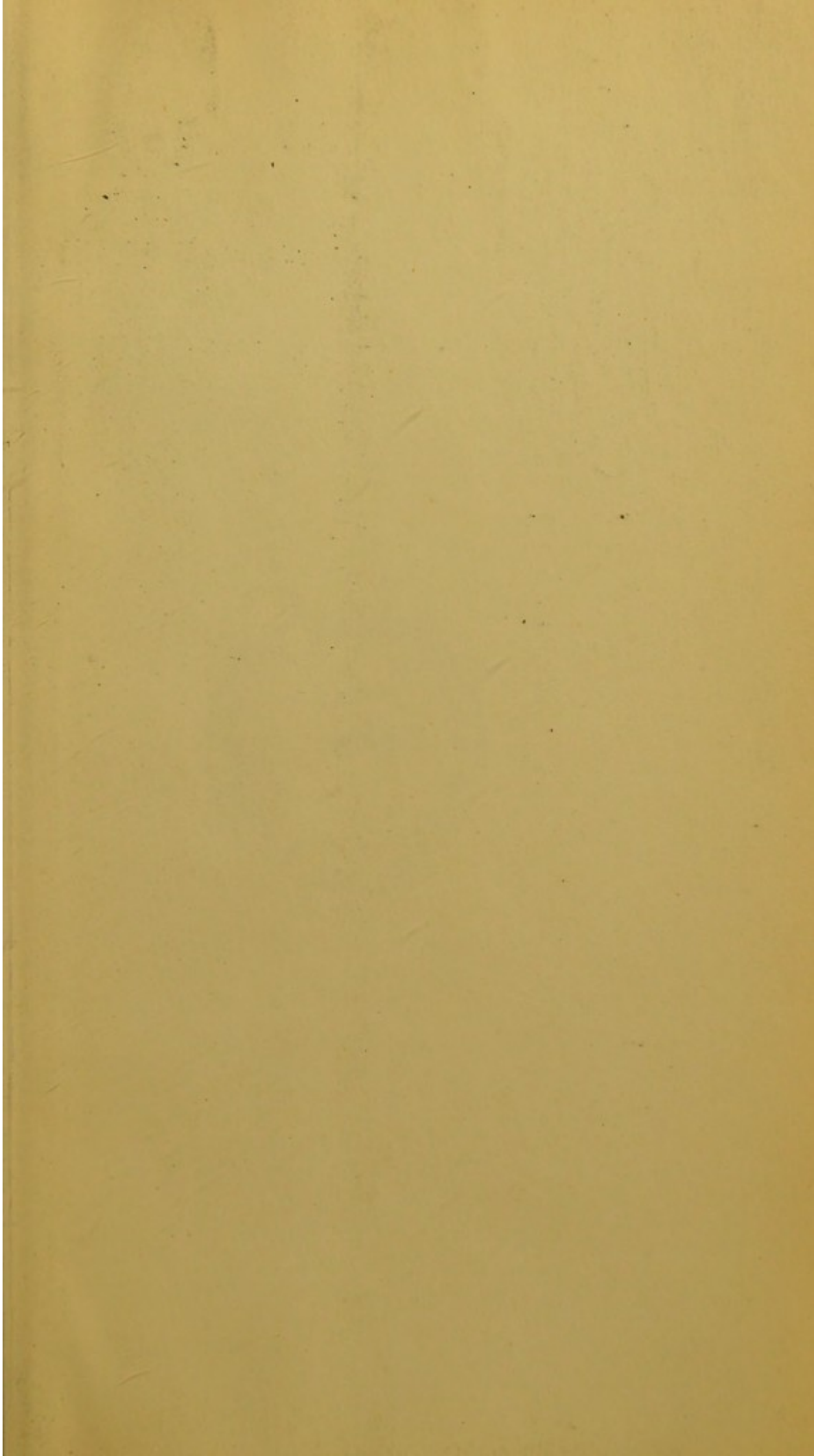
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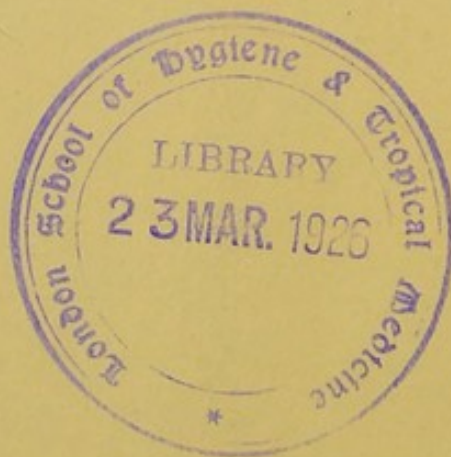
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