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The Bubonic plague : a popular lecture / by Sir Thomas Peter Anderson Stuart

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# THE BUBONIC PLAGUE

## A POPULAR LECTURE

BY

PROFESSOR

ANDERSON STUART, M.D., LL.D.

(SYDNEY, MAY, 1900.)



PRICE, 6D.

By Authority:

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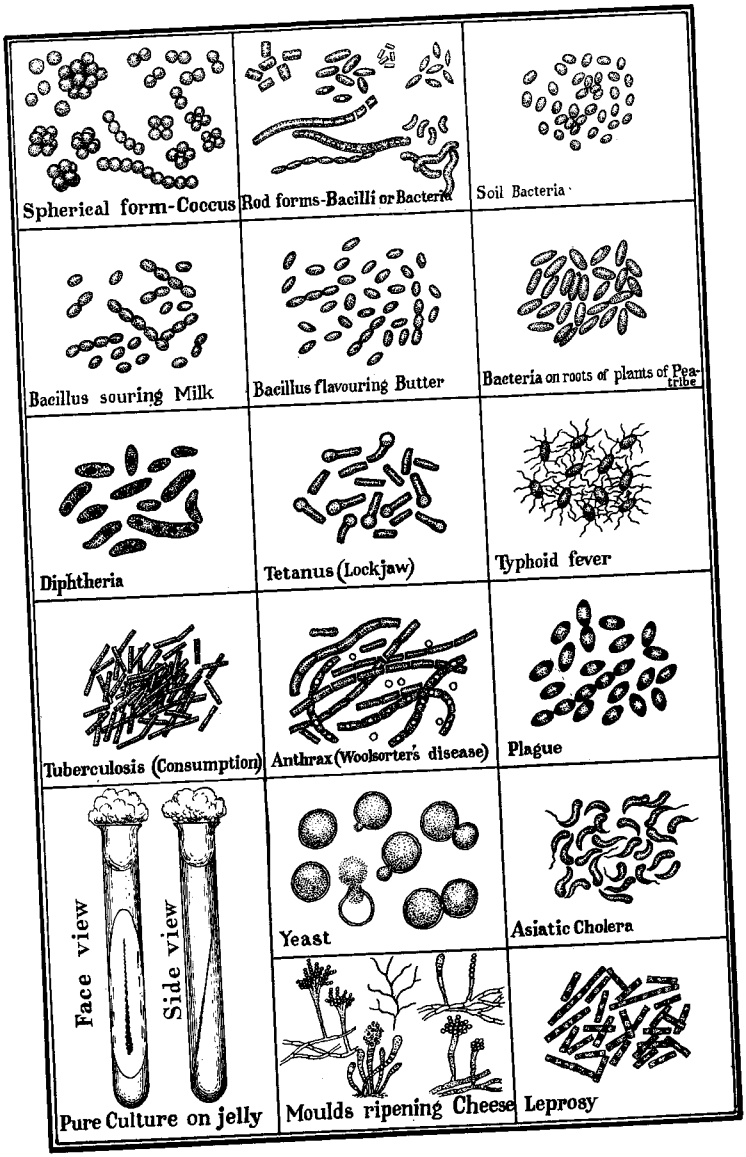
Spherical form-Coccus
Rod forms-Bacilli or Bacteria
Soil Bacteria
Bacillus souring Milk
Bacillus flavouring Butter
Bacteria on roots of plants of Pea-tribe
Diphtheria
Tetanus (Lockjaw)
Typhoid fever
Tuberculosis (Consumption)
Anthrax (Woolsorter's disease)
Plague
Face view
Side view
Pure Culture on jelly
Yeast
Asiatic Cholera
Moulds ripening Cheese
Leprosy

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Foreword by the Hon. Sir Wm. J. Lyne, K.C.M.G.


*This Lecture, delivered by Professor Anderson Stuart, M.D., is so opportune and instructive that I think it should be published and distributed for general information.*

*William John Lyne.*

*Premier's Office,*

*May 23rd, 1900.*

# THE BUBONIC PLAGUE.

## A POPULAR LECTURE, SYDNEY, MAY, 1900.

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### Knowledge of the Disease allays Anxiety.

THE disease has been aptly described as a battle between the man and the microbe, and clearly the more one knows of one's enemy and his ways the greater is one's advantage in the strife. Knowledge undoubtedly diminishes anxiety and prevents panic. See with what serenity medical men and trained nurses have moved about among the plague-stricken in the hospitals here and in India!

We have long been accustomed to think and speak of the plague among civilised peoples as a thing of history merely—a disease that raged in ancient times, in the Middle Ages, and before the birth of the science of our day, but as quite incompatible with modern sanitation and hygiene. And yet the plague is in our midst. Thanks, however, to the genius of Pasteur and his pupils and followers, we are not now stricken down with fear of the disease, but are full of hope and strong to fight it and to beat it—aye, perhaps, to vanquish it yet.

### Historical.

The word "plague" is derived from the Greek "plēgē," meaning a stroke or blow given by a sword or other weapon, and hence a stroke or blow of calamity; finally, a swiftly calamitous disease or pestilence. *The* plague

is the bubonic plague; it is *the* pestilence *par excellence*, "the pest." The word "bubonic" is also from a Greek word, "boubōn," meaning the groin, in reference to the buboes or swellings in the groin, which are so characteristic of the disease. The origin of the words thus tells a great deal, for the plague has been dreaded beyond all other diseases, coming suddenly, generally, but not always, accompanied by swellings in the groin and elsewhere, killing its thousands—its millions—disappearing for a time, only to come again.

The earliest references to what is possibly plague are in Holy Writ, for it is possible that the plague is referred to by Moses as one of the curses for disobeying the Commandments; and when the Philistines captured the Ark of the Covenant, wherever in Philistia the Ark was carried, dire disease broke out among the people, and, so far as the descriptions go, they rather indicate bubonic plague.

Not until the 6th Century, A.D., in the reign of the Emperor Justinian, did the plague appear in Europe, though long before that time it had been known as a common disease in Northern Africa. When it did invade Europe it had apparently broken out explosively in Egypt, and thence spread throughout the whole of the then known world. It is recorded that 10,000 died in one day in Constantinople at that time. Since then it has been more or less prevalent in Europe and elsewhere.

The "Great Plague of London" in 1665 preceded the sudden disappearance of the plague from England, but from the 14th Century onwards until this time the scourge had never been absent from England. About this time also it began to disappear elsewhere. By 1839, leaving Constantinople last, it had ceased on the continent of Europe, after a career of 1,300 years, during all of which time it had been the terror of the peoples. By

1844 it had ceased in Mediterranean lands, and with its disappearance from Egypt it seemed to have become wholly extinct everywhere.

Unfortunately the complete extinction of the disease was only apparent, for nine years after its disappearance from Egypt it appeared in Western Arabia, and then in country after country about the Mediterranean until, after an absence of thirty-seven years, it again appeared in Europe, in the province of Astrakan, in Russia.

**The Permanent Homes of Plague,—"Endemic Centres."**

There are some ten regions of Africa and Asia where it seems never to quite die out at all—always being there as a disease characteristic of the place ("endemic"), and thence occasionally spreading to become more or less widely epidemic. These places are in Northern Africa (Bengazi District), Uganda (in Central Africa), Arabia (Assyr District), Armenia (Euphrates District), Persia (Kurdistan and Khorassan), India (Himalayas—Guhrwal and Kumaon), China (Yunnan), Siberia (Lake Baikal). The Uganda and Baikal centres have a future importance, since the one is on the line of the Cape to Cairo railway, the other is on the Trans-Siberian.

Why it spreads as an epidemic is unknown. Attempts to associate its virulence with changes in the earth, the seasons, and the climate, &c., have not yet succeeded. The association of the virulence of typhoid fever, for instance, with the seasons of the year is well known; but why its virulence varies in different years is unknown. Many other diseases show this periodicity, equally inexplicable; for instance, why the distinct increase in diphtheria during the past forty years or so? There is a rise and fall of microbes as of peoples—both are living organisms—the causes are always complex and not always discernible.

## Whence came the Present Epidemic.

One of the permanent homes of plague, as already said, is Yunnan, a province of Southern China. From Yunnan, in 1892, some mule-drivers travelled a distance of 160 miles to Long-cheou, and there developed plague. Thence in 1893 it spread a distance of 150 miles to Pakhoi. In February, 1894, it got to Canton, where it killed 100,000 out of a population of 1,600,000, and from here it was carried to Hong Kong by fugitives in April, 1894. From Canton and Hong Kong it spread to several places around. In September, 1896, it appeared in Bombay, and this was the beginning of the present epidemic in India. From Bombay, owing to its commercial relations with almost all the world, it soon spread. In one direction it has affected Aden, Alexandria, and Oporto; also London, where three deaths occurred in 1896, but it was then extinguished. In another direction, Mauritius, Réunion, Madagascar, The Cape, and Monte Video, Buenos Ayres, Santos, Ascuncion, and Rosario, in South America. In a third direction, Manilla, Nha-Trang, Penang, and Noumea. The present outbreak in Australia began in Sydney on the 19th of January this year. Whence it immediately came is not certain, but, considering the intercourse between the places and Sydney, and noting what ships have been in Sydney, Noumea especially, but also Mauritius, are both likely enough. Thus it has crossed the great oceans—Indian, Atlantic, and Pacific—for it has reached Honolulu and San Francisco, too. In the foregoing we see how the plague ever spreads—by a series of halting-places, each becoming a new focus of infection from which the disease radiates, and so it is important to recognise the first cases, that we may try to extinguish the fire before it breaks out into a conflagration.

### The "Black Death" may have been Plague.

The "Black Death," which devastated half the world in the 14th century, may have been bubonic plague, though authorities are not all agreed as to that. It, too, came from the China direction, for in 1347 the Tartars invaded Southern Russia, and besieged the Christian merchants collected in Gaffa, on the Crimean Coast. "The Death" broke out among the besiegers, and thousands died daily. Dead bodies thrown into the city carried the disease to the defenders, who ultimately took to their ships and spread the disease in succession to Constantinople, Messina, Genoa, Venice, and Marseilles. From these maritime places the disease rapidly spread northwards, so as to invade nearly the whole of Europe, and slay 25,000,000 out of the 105,000,000 of inhabitants then in Europe. It would be easy to give most interesting and impressive pictures of the havoc, moral as well as material, wrought by the disease at that time, but it would not serve any good end just now, when my object is to allay anxiety rather than to foment it.

When the "Wrath of God" ceased to be regarded as a sufficient explanation of "The Death," the Christian peoples sought a material cause, and found it in the Jews having poisoned the wells with a mixture made from the diseased buboes, spiders, and poisoned animals! Under the torture, of course, confessions were obtained, and, persecutions commencing, thousands of Jews were killed. In one city 2,000 were burned, by way of curing the disease, while in other towns, by way of preventing it, all the Jews were exterminated! Is it not, then, interesting that the inventor of that plague-preventive, the prophylactic so lately used in Sydney, Professor Haffkine, is a Jew, born in Russia, and working under the British flag in India?

**The Real Cause of the Plague—The Actual Contagion or Disease-bearing Thing.**

An immense advance was made in Hong Kong during the epidemic of 1894 by the Frenchman, Dr. Yersin, in discovering the bacillus of the plague, for now not only do we thus know the material cause of the disease, but we also thereby know how to arrest the spread of the malady and cure the patient. This bacillus, like that of tuberculosis or consumption in its various forms, like that of typhoid fever, diphtheria, Asiatic cholera, leprosy, glanders, tetanus or lock-jaw, wool-sorter's disease or anthrax, and many other diseases (see figures), is a minute organism of vegetable nature.

So easily does man believe what he desires that we often hear, that this or that person does not believe that we have real plague in Australia—he thinks it is "bad typhoid," or "bad typhus," for such wiseacres do not usually know that there is a difference between typhoid and typhus. But "seeing is believing"—one can see, by means of the microscope, that the bacilli of the diseases are different (look at the figures), and thus, partly, Dr. Tidswell was able so early to absolutely diagnose the first case that we know of as having occurred in Sydney. So long as we had only the symptoms to depend upon for a diagnosis, it was always a difficult matter to be quite sure of the first few cases, which in most epidemics are of a mild character. Now, however, we can put the matter to the test with great accuracy, for if we find the special bacillus we know it is the plague with which we have to deal. This alone shows the importance of the work done by the Board of Health when I was its President, in establishing the very complete micro-biological laboratory, now in Macquarie-street, under Dr. Tidswell's charge.

These organisms are excessively minute—625 millions of the plague bacilli would just cover a square inch of surface. They are therefore called "micro-organisms," or "microbes" (the word means "minute living things"). They are also called "germs," in reference to their power of growth and reproduction. They are the lowliest plants, but are devoid of the green colouring matter, or "chlorophyl," so characteristic of the higher plants. They are largely named according to their shape, *e.g.*, little rods or "bacilli" (if the rods are somewhat shorter they are "bacteria"), and little balls or "cocci." (See figures.) Some, such as the typhoid bacilli, have lashing, tail-like appendages that keep them in motion. The plague bacilli discovered by Yersin have no such appendages. They occur as somewhat short rounded rods, in enormous numbers—especially in the swollen glands. When stained with aniline dyes the ends, or "poles," are more deeply tinted than the middle part—this is the so-called "bipolar-staining," which is one of their distinguishing characters. (See figure.)

Microbes multiply by growing to a certain size and then simply dividing into two new ones. If this occur every half-hour (and while some divide more slowly others divide more quickly than this) and all survived, 17 millions would, at the end of the twelfth hour, represent the original single parent germ.

### External Conditions influence Microbes.

Microbes thrive best at a moderate temperature: freezing suspends their activity, so that frozen meat does not putrefy, putrefaction being due to microbes. On the other hand, the temperature of boiling water is generally fatal to them, and thus meat preserved in cans keeps, because the boiling, to which it was subjected

before the can was sealed, has destroyed all the organisms. While freezing suspends their activity, boiling definitely destroys it. Thus boiling, steaming, and heating, are so useful in disinfection. The plague bacillus easily succumbs to heat—largely because it exists only in what is called the "vegetative form," which is easily killed, and does not, as far as is known, produce a more resistant form of the organism called a "spore," seen as little round bodies in the wool-scourer's disease germ. (See figure.) Yet it is certain that clothing may preserve the contagion a long time, and carry it long distances, as if there *were* some unknown resistant form after all. It seems difficult otherwise to explain undoubted facts. Whether merchandise and other such inert objects may carry the infection is very doubtful. As Hankin remarks, the plague bacillus, from its behaviour in the laboratory, is a frail thing, yet in nature it seems to be endowed with a force of resistance equally extraordinary. This may find its explanation in the suggestion of Batzaroff that there are different varieties of the plague bacillus, some specimens of which are exceedingly resistant.

Exposure to sunlight kills plague bacilli in four hours, and the same is true, more or less, with many other microbes—hence the importance of plenty of light in the dwelling.

Mere drying stops their activity in all cases, dampness favours it. The plague bacillus has been killed by exposure in a room for four days, though others have found them alive after a month or longer, especially if contained in dried organic matter, such as expectoration of plague patients. Fruit and vegetables are preserved from putrefaction by mere desiccation, and the "biltong" of the Boer and "pemmican" of South America are simply dried ox-flesh.

Disinfectants, when efficient, act by killing the microbes, as poisons kill men. Thus it is not enough merely to distribute the disinfectant anywhere about, so that, for instance, the air smells strongly of it; the disinfectants must come into actual contact with the microbe, and that in sufficient strength.

### How the Pure Microbe is obtained.

Just as moulds are every day seen to grow on stale bread, cheese, glue, &c., especially in warm, damp weather, so the various microbes, including the plague bacilli obtained from cases of the disease, sown on the surface of various jellies and in meat soups, &c., readily grow. In this way pure crops, or "cultures," are cultivated in glass tubes in his laboratory, by the "bacteriologist." (See figure.) The tubes are closed with a plug of cotton-wool to prevent the advent of other organisms from the air. The jelly is inclined so as to get a large surface.

### To prove that the Pure Microbe causes Plague.

That the bacillus is the true cause of plague is proved thus:—

*a*. Cultivated again and again, it retains its form and properties—thus it is something definite in its nature.

*b*. It is never found in the healthy animal nor in any other disease.

*c*. Introduced into an animal that is susceptible—*i.e.*, will take the disease—it multiplies therein and produces the disease.

*d.* Transferred from that animal to another susceptible animal, the disease is always reproduced as before. The dissemination of the plague thus arises from the dissemination of this microbe.

### The Action of the Microbes.

The symptoms of the disease generally are due not so much to the mere presence of the microbes, however numerous, as to the substances produced by them, just as one does not get exhilarated on the yeast plants, but on the alcohol they produce. Some such products are visible colouring matter—red, green, orange, &c.; others are judged of solely by their effects on the body; some are virulent poisons or "toxines," and such are the products of the plague bacillus.

### Many Microbes are Harmless, Necessary and Useful.

But microbes are not always noxious. Some bacteria have distinctly useful parts to play; for instance, they help to break down into their elements the dead bodies of plants and animals and their excreta; thus by their agency, largely, the dead are restored to the earth from which they came—dust to dust, and ashes to ashes. Others are concerned in making up that dust into forms available to the higher organisms—for instance, the roots of plants of the pea-tribe *(leguminosæ)* are studded with little nodules containing microbes, which cause the conversion of the nitrogen of the air and the contents of the soil into organic matter rich in nitrogen. In this way "green manure" derives its value. The soil teems with microbes; when they are destroyed, it is no longer fertile. They are of immense use in the arts; they are the agents

at work in many fermentations, in making alcohol in its various forms, vinegar, butter, cheese, bread, linen, &c., &c., &c. (See figures.)

**Animals that "take" the Plague, i.e., are "Susceptible."**

Rats, mice, guinea-pigs, marmots, rabbits, oxen, buffaloes, sheep, goats, pigs, fowls, dogs, cats, and monkeys are among the animals variously stated to be "susceptible," while it is also stated by some that oxen, dogs, tortoises, and frogs do not take the disease or are naturally "immune." Some animals, especially rats, mice, monkeys, and a kind of marmot in Siberia, are extensively affected by natural means in epidemics affecting man, but it is impossible to say how far other animals susceptible experimentally, *i.e.*, to which we can communicate the disease, say, by inoculation, "take" the disease by natural means as rats do. In one month, in Canton, the carcases of 40,000 dead rats were found, and dead animals found in the affected region often contain the bacilli.

Dead flies, for instance, found in the affected area, contained the bacillus, and when bruised in water and inoculated into susceptible animals produced the disease. Clearly, therefore, catch or keep away flies, and keep them from the food of man. Perhaps mosquitoes play a part, as they certainly do in producing malaria.

There can be little doubt that rats play the most important part in spreading the disease to man. That there was pestilence among rats about the same time as among men has been known for centuries, perhaps thousands of years, but it is only since the discovery of the bacillus, that the identity of the disease in man and the rat is proved. The explanation of how the bacillus is transmitted from the rat to man is new, and most interesting when considered in such detail as to be thoroughly understood. Let us, therefore, take it up in detail.

**Rats and the Plague.**

Simond, a French investigator, from researches in Bombay, 1898, showed, apparently most conclusively, that the flea of the rat is probably a common, if not the most common, means by which the disease is spread from rat to rat, and, probably, from rat to man. (From man to man the common louse and the bug may play a part, but not an important one.) It may at once be conceded that, in view of the ease with which the bacillus is killed when it leaves the body, it is a natural suggestion, that it passes into some other host in whose body it is protected and by whom it is transferred to a new host.

Simond recites what, for the most part, had been shown by Snow, in Bombay (1896–7), viz. :—

1. It is probably man who carries the disease long distances at a time, but that it is the rat which spreads it in a neighbourhood, making the disease epidemic: at all events it is generally admitted by medical men that direct transmission from man to man, except perhaps in lung cases, is not common.
2. Diseased rats coming into a healthy neighbourhood are always followed in a few days by cases in man, but diseased men coming into a healthy locality do not always lead to other cases. When they do, probably the rats have been first infected, thus accounting for the interval of several weeks between the imported and the succeeding cases—during this time the rats are being affected. The plague infection, once having been introduced by rats, may continue in the place long after their complete disappearance. It is a fact that plague hospitals have not become centres of infection to their

neighbourhood, because, owing to the precautions taken, the rats are not allowed to become infected.

3. The severity of the epidemic amongst men is proportionate to that amongst rats, and the direction in which it spreads is the same as that taken by the emigrating rats, for this the rats do in a sort of panic. In Formosa the people call it " Rat sickness."

Simond's explanation is as follows :—When the rat is sick it is unable to keep itself free from fleas, which, therefore, batten on it and fill themselves with the rat's blood, and this towards the end of the disease almost certainly contains plague bacilli. The bacilli from such fleas inoculated into mice caused the disease. Fleas whose stomachs contained the bacilli have been found here in Sydney by Dr. Tidswell, who took these fleas from off plague rats. Simond says that a healthy vigorous rat keeps itself free or almost free from fleas ; but Dr. Norton Manning of Sydney, twelve months ago, saw an apparently strong vigorous rat spring from the wharf to the ferry steamer ; it was caught by the deck hand, whom it bit, but who squeezed it to death in his fingers, and while this was going on Dr. Manning saw at least a dozen fleas jump on the man's bare fore-arm. When animals die the fleas leave them—that I have seen hundreds of times : as the animals cool the fleas collect in the surface part of the fur, ready to spring on any suitable host. Simond gives this reason for it being so dangerous to handle a rat recently dead of plague : one dead a long time may be handled without such danger, for by this time all the fleas have left it.

He claims to have proved his theory experimentally, thus :—a certain number of rats are examined carefully,

so as to make quite sure that they are free from fleas; some of the rats are now inoculated with the disease, and are put into the same cage as the others; those inoculated duly develop the disease, but do not communicate it to the uninoculated. If, however, fleas are purposely introduced, the disease does spread to the uninoculated—Simond says because the plague fleas succeed in biting the healthy rats before being killed by them.

His investigations were carried on in India, where people walk about with bare feet, and he says he has often found about the thin skin of the exposed ankle a little pimple or blister, marking the bite of the flea and point of entrance of the bacilli.

This theory certainly explains why plague haunts the poor, and why it clings to badly kept and dirty houses, and especially to rooms on the ground floor—these are just the places where rats most abound. It explains the usefulness of cleansing the floors; the safety of work in the laboratory with the bacilli; the danger of the recently dead rat; the great frequency with which grain and produce dealers and people working about the wharves are attacked, &c., &c. It also shows a way in which the bacilli can survive after they have left the plague rat, and before they enter another animal, for we have seen how easily they die and are killed. On the other hand there seem clearly to have been epidemics, *e.g.*, at Hurdwar in India, where the rats evidently played no part; and according to some zoologists, the rat did not exist in England at the time of the Black Death, 1347, being imported only in the 17th Century. The last word on this subject has not yet been said.

It has been objected that the fleas of the rat are not the same as the fleas of man. The former, it is said, are little grey fleas, man's being big and brown; but fleas, actually taken from rats in the Board of Health Labora-

tory in Sydney, could not be distinguished from those taken from some human inhabitants of Sydney. It has also been argued that as many other animals have their own kind of flea, so the rat has, and that the rat's kind will not bite man. This brings to one's recollection Swift's lines:

> Hobbes clearly proves that every creature
> Lives in a state of war by nature;
> So naturalists observe a flea
> Has smaller fleas that on him prey,
> And these have smaller still to bite 'em,
> And so proceed *ad infinitum.*

But is it not likely that they would at least taste his blood before finding out that it was distasteful? If they did, that one bite might be enough, and have we not all fondled animals, and been very busy afterwards? Moreover, some people are never bitten by fleas, just as others are sure to be if one is in the neighbourhood—I know a man who actually fishes for them with his bare leg, when he wants to catch them. The matter, however, really was settled by Simond, who took fleas off a rat, placed them on men and on dogs, and saw them immediately attack their new host.

Something very like an elaborately planned experiment occurred in the human subject as follows:—The P. & O. R.M.S. "Shannon" left Bombay in February, 1898, and nothing unusual occurred on the voyage to Aden, nor while she lay there, and there was no plague in Aden. On the return voyage, however, dead rats were found in the mail rooms, and in due time the post office employee on board developed plague. As he was embarked at Aden, where there was no plague, and did not come from a plague place, the only explanation seems to be the dead rats, the disease having come with the rats from Bombay.

The city of Paris has just taken steps to forestall the plague by a crusade against rats. One of the means of killing them adopted, is to infect them with a microbe which kills them and various sorts of mice, spreads from one to another and yet is harmless to man and domestic animals. This is carried out by dipping pièces of bread, grain, &c., in water containing the microbe, and is said to be very effectual both for rats and mice. The microbe is sold freely by the Pasteur Institute. But it is not easy to kill rats. In spite of the utmost vigilance they elude us, just what the plague bacillus does, and this is but another argument for the rat-borne theory of plague.

**How the Bacillus gains entrance into the body.**

Most writers believe that it is commonly by way of the skin, through wounds, cuts, abrasions, or cracks. A needle dipped into a culture of plague bacilli may, by a simple prick, convey the disease and yet nothing may remain to mark the point of entrance. If experimentally this is so, it may be the same upon natural inoculation, so that the point of entrance remains unseen. When bacilli are applied without any excoriation to the membrane of the eye (conjunctiva), or to the lining of the nose, or to that of the wind-pipe, or sometimes when the animal is made to breathe dust charged with bacilli, a most virulent kind of plague—that of the lungs, is produced. The disease is not likely to be directly acquired by the breath however, unless when a patient coughs near one, or when a great many patients are collected together. By the mouth it may enter in contaminated food and otherwise.

Water does not seem to be a common vehicle of the bacillus. Milk generally speaking is one of the best possible breeding places for microbes, hence the necessity

of seeing to a pure supply, and of Pasteurising, or of boiling it as the case may be, so as to kill the microbes which may be there. Dust collected from the walls of rooms where plague patients had died conveyed the disease by inoculation to mice, and such dust might be breathed or might contaminate the food, hence the necessity of washing walls, floors, &c., in disinfecting plague houses. The bacillus has been found in all the excretions of the patients except the sweat. Probably the soil harbours the bacillus when fouled by these excretions. Clothing undoubtedly preserves the bacillus in a virulent condition for months, or may be for years. Possibly, as already suggested, there is an as yet unknown more resistant form of the bacillus, as is known to be the case with some other bacilli (anthrax), that enables it to survive so long, for the ordinary form, applied experimentally to linen and the like, does not survive more than some four weeks. A body dead of plague may be contagious for a time, but the organisms of putrefaction kill those of the plague, so that none of the latter were found surviving inside the body beyond thirty days at the outside, and in no case were bacilli found outside the coffin. This affects the question of cremating plague bodies, and throws serious doubt on the oft-repeated statement, that plague bodies, exhumed after many years, have given rise to new outbreaks of the disease.

As well as patients manifestly ill of the disease in one or other of its forms, there is a minor form of it, which does not compel the patient to go to bed or even lie down; he may walk about, following his usual avocation, and yet be the subject of plague, and possibly communicate it in a grave form to others. Such cases are apt to be met with when an epidemic is commencing and when it is passing away. Thus the earlier cases are sometimes never suspected until the graver forms appear; then, on looking

back, the death-rate will be found to have been increased for some time, doubtless due to unrecognised plague cases. Thus the first case found in Sydney was merely suspected for a few days, until Dr. Tidswell found the bacillus. Further, there seems reason to say that the patient must not be discharged too soon after the attack, for the bacillus is said to have been found in the excretions for some time after convalescence has commenced.

### Circumstances favouring outbreaks of Plague.

Low-lying and damp soils and a warm and humid atmosphere—warmth and moisture favour all microbes; yet the plague also occurs in mountainous regions, and it also occurs in Siberia and Manchuria, which are cold countries. Simond would point out that rats are found in all these places, that, in fact, wherever men are, rats are, or may be: the rat is the constant companion of man, who provides it with all it needs—food and shelter.

Old, low, dark, badly-ventilated, badly-constructed, damp, dirty, and over-crowded houses. Simond says that these are just the circumstances in which rats and parasites abound.

Unwholesome and insufficient food, physical and moral misery—these all reduce the resisting power of the body, and, indeed, the bubonic plague was called the "Poor's Plague" at the time of the great plague of London. Thus plague has often followed famine, sieges, &c.

Neglect of public and private sanitation, accumulation of filth about and within the dwelling, personal uncleanliness—these tend to diminish the body's resistance, and also are just the conditions favouring the presence of rats and the attacks of parasites. The garbage "tip," in most places, should be abolished, or

should be modified by mixing the stuff with soil or sand or both, and covering all over with a layer a foot thick of the soil, in order that the bacteria, which are the natural agents in destroying organic matter in the ground, may have a chance of carrying on their beneficent work. It should, however, be clearly understood that the filth does not produce or generate microbes any more than it spontaneously generates roses—the one, like the other, must be sown or introduced; the filth only provides the suitable soil. Moreover, even if such disease-producing microbes as the plague bacillus were introduced with the garbage at the tip, they would soon be overpowered and killed, for they would have to compete for a living with the microbes of putrefaction. They would be as delicate plants among weeds. They would speedily be overgrown and starved out.

The more intimate their relations are with the sick, the more likely are the healthy to be affected; but, on the other hand, as the immediate source of infection, the place is more important than the patient.

The place is infected by the excretions of the human or other patients, or by the presence in it of infected things. The proof of the influence of place is simple—remove the people from it, and at once the cases diminish or cease. Thus, of 1,130 contacts removed in Sydney up to date, only six have developed the disease, and circumstances warrant us in saying that they most probably got the infection, not from the patients themselves, but from the same sources as they did. It thus becomes of the utmost importance to discover early, and deal with, the first case in the district, so as to prevent the place from becoming infected, for measures then adopted do not yield satisfactory results.

When all this has been said, it must still be remarked that the disappearance of the plague in the 17th century

was comparatively sudden, while the advance in public and private sanitation and hygiene has been exceedingly gradual. The Great Fire of London occurred in September, 1666, just one year after the worst of the Great Plague, and is generally, but probably erroneously, credited with the extinction of the plague. The plague really commenced in the suburbs, which were not touched by the fire, and it did not disappear till 1679. Evidently we cannot really, as is so often done, ascribe this disappearance of the plague entirely to our improved conditions of life. On the other hand, we can just as little ascribe its reappearance in Sydney entirely to filth and filthy ways.

**The great thing we have now to recognise!**

It is not the patient who is the chief source of danger, and still less is it the people associated with him—the "contacts." Collie tells us, speaking of the present epidemic in India, that it is not rare to see plague-mothers, even those who have the disease in the pulmonary—its most infectious—form, suckle their infants without communicating the disease, and also plague-infants nourished by their mothers without the latter contracting the disease. It is the infected house or place in which he contracted the disease which is to be feared. In this place the plague may be caught without any contact whatever with the patient, and hence the wisdom of evacuating the place for a time—disinfecting, cleansing, and airing it thoroughly. It is in enabling this to be done properly, and in taking them away from a dangerous place, that the real justification of removing the contacts is to be found. Destroying the place by fire or other means may sometimes be advisable, but it is not to be the rule everywhere.

This overwhelming influence of the place rather than the patient is recognised by the villagers in the Himalyas and in Uganda where the disease is prevalent. So soon as they see the rats dying, or a case occurs amongst themselves, they at once go away into the jungle, where they stay for a month after the last case, and the inhabitants of the other villages will not receive them, for they have learned that the strangers may bring the disease with them. Another example: in Hongkong the disease was almost confined to the Chinese, but very few Chinese were attacked who were living as servants in the houses of the Europeans, and were therefore in sanitary places and under sanitary conditions.

From the foregoing it is clear that no longer need the plague-stricken be shunned and left to live or die alone, as they were in former times, when the Priest would even administer the sacrament with a long silver rod. They are to be treated as carefully and as lovingly as other sufferers are, but *not* in the infected place. It is related by Surgeon-Captain Thomson that in a Bombay hospital where 240 cases were treated, the doctors, nurses, and 140 servants remained unaffected—the attendant in the *post-mortem* examination room alone excepted, and he probably pricked his finger. Also, that there were numerous visitors, 20 of whom hardly left the bedside, and not one of these was affected.

**Hospital Treatment versus Treatment in Private House.**

Patients are well advised to seek treatment at a special plague hospital, for—

1. They have there the constant care of medical men and nurses skilled in the treatment of the disease as a specialty. This is important, because the symptoms vary greatly, and an emergency may arise at any

moment. For instance, failure of the heart's action is a common complication; stimulants given judiciously now may mean just the difference between living and dying. If the patient had a private doctor in the ordinary way he could not be always at hand, and, the crisis occurring, the patient may have gone before the doctor came. Is it not fair to say that the remarkably low percentage of deaths to cases in Sydney, viz., only 32 per cent., has been due to the fact that all patients discovered in time have been treated in the plague hospital?

2. The journey to the Sydney Quarantine Hospital, on absolutely reliable evidence, does no harm. It has not done harm in one single instance, despite the more passionate than rational writings in the daily Press. In a critical time like the present, it is impossible to foresee every eventuality and avoid occasional delays, but I candidly say that I believe the best possible has been done in every case, and were I attacked this instant I should, of my own motion, go straight off to the plague hospital at the Quarantine Station, and in doing so I consider that I would be doing the best thing for myself and my family.

3. Treatment in the patient's own house, as well as being generally undesirable, is, in the present state of public opinion, impossible. It would mean that each house attacked would become a little hospital, with its doctor and staffs of nurses and servants. Remember, too, what I said about the place as against the patients, and supposing that it was in his dwelling that the patient got his infection we may ask—Why should doctor, nurses and servants be confined to an infected and infective place? It would be monstrous, and for the same reason, to quarantine

the ordinary contacts in the place where the patient's infection was, we must assume, obtained, would be cruel to the contacts, and the surest way of disseminating the disease. This last was at one time the course adopted during the Great Plague of London, and its results were disastrous; almost all the contacts took the disease.

**Periodic Increase and Decrease of the Plague.**

That the season has an influence on the disease is is undoubted, but it is not easily understood. In Levantine countries, China, India, and in a general way in other tropical countries, the disease ceases during the hot weather; and yet at various places in India it was at its worst in the hot weather. In more temperate climates, as in London in 1665, at Marseilles in 1720, and in Turkey, the reverse was the case. In London it was at its worst in the first fortnight of September—it lasted from May to October. In Oporto last year it was worst in October. In Moscow, where it is very hot in summer, and very cold in winter, the plague was as bad at one time as the other.

Simond claims that the rat, and not the season, is the cause of the periodic increase and decrease in any given place. He says that it lasts some 7–8 months, or until the rats have died or emigrated, or have the disease in an attenuated form, and only breaks out again when the emigrated rats or their progeny return to the infected region. The existence of this attenuated form of the disease has been demonstrated by Hankin.

The disease may spread slowly; thus it took four months in the Great Plague to spread from the west to the east end of London, even of that day, when it had just the same population as Sydney has now. It spreads irregularly as to both time and space; thus it is apt to

engender hopes that the disease is dying out, when a severe epidemic may follow. This happened at Alexandria last year, when there were no cases from September 4th to September 24th; also in Madagascar last year, when there were none from February to December.

The disease has generally lasted for several consecutive years in a place, and, periodically, each year showing such a marked decrease as to give rise to the hope that it was disappearing. We must wait a considerable time before assuming that it is really disappearing definitively.

### The Influence of Age and Race.

No age is exempt, but generally the disease is more severe in adults than in children.

The Asiatic races seem more prone to contract the disease than are Europeans, even amongst educated persons in similar surroundings, *e.g.*, in Hongkong, while every one of the eleven members of the English Mission escaped, only four out of the seven members of the Japanese Medical Mission escaped attack. Moreover, when the disease does attack the European, it is not so fatal as in the case of Asiatics.

### Development of the Plague.

"Incubation," is the technical term denoting the interval of time between the reception of the microbe and the manifestation of the disease. The maximum is generally given as 10 days, the average 5 days, the minimum $1\frac{1}{2}$–4 days, though it is probable that in its attenuated forms the disease may take several weeks to declare itself. On the other hand, Simond states as the result of experiment, that the incubation should be taken as not more than 4 days, and that it may be as short as

½ day. When the disease develops it may do so with such rapidity that death may occur almost suddenly, but this is not usual. This is the "fulminant" or lightning-like case. At the other extreme, as already said, the case may be so mild that the patient may go about his usual avocation. This is the "ambulant" or walking case. Generally it is exceptional in neither way, but is gradually developed as a grave disease, accompanied by that painful swelling of the glands of the groin, armpit, or neck, to which the name "bubonic" is due. The exact character of the symptoms varies in different epidemics, at different periods of the same epidemic, and in different cases. The fatality of the attacks is very various too—up to 95 per cent. or even more, while at other times it may be down to about 30 per cent., as in Sydney. This last is the classical type of the disease. Unfortunately one attack protects from another only for a certain time, so that the disease may come again, but that there *is* such protection is the basis of the new treatment of the disease.

**Treatment of Plague.**

The treatment of the disease is based upon the general lines followed in the case of other infectious or contagious diseases, but in addition there are now special cures by the prophylactic of Haffkine, and the anti-plague serum of Yersin. Most medical men have never had an opportunity of seeing the disease, but it is comforting to the public to know, that in Sydney we have most competent men to diagnose and treat the disease, men in whom we may have every confidence. In support of this I may mention, that although there have now been 192 cases, no one has been sent into the plague hospital who afterwards turned out not to have the disease, nor has anyone been reported and declared by the Medical Inspectors

not to have the disease, who afterwards turned out to have it. I have already said that the fatality has been only 32 per cent. This is a record with which we may well be satisfied.

### Susceptibility and Immunity.

In order that a person may "take" a disease depending upon the attacks of micro-organisms, his body must be more or less "susceptible"—absence of susceptibility is called "immunity." In order that we may have a crop of potatoes, not only must there be seed potatoes, but there must be a susceptible, a suitably prepared, and fertile soil. Rats and mice, for instance, which by a natural susceptibility, take plague so readily, by a natural immunity to the disease completely resist the diphtheria-organism. Not everyone who is exposed to a disease of microbic nature takes the disease. Why? We do not quite know, but it is certain that many disease-producing organisms must daily find their way into our bodies and yet are lost, for the interior of the body has none of them, and many, actually injected into the body, gradually disappear without producing evil results. It would appear that the healthy tissues and fluids of the body, either exert an antagonistic action to, or do not serve as a suitable soil for, the growth of the organisms. This antagonism may also extend to the products of the microbe's action, the toxines, and it may be greatly increased naturally and artificially. Naturally it is increased during the course of the disease. As regards the organisms themselves it is seen in typhoid fever, for if some of the blood of the patient is taken, and virulent typhoid organisms are added to it, by the microscope the organisms are seen to be ultimately destroyed, and it is this gradual development of the

antagonism during the course of the disease that helps to bring the attack to an end. The disease is thus, to a certain extent, self-limiting. The antagonism to the toxines is well seen in diphtheria, where the "anti-toxine" treatment of the disease, by conferring immunity to the effects of the diphtheria poison, has reduced the mortality to one-third of what it used to be.

The antagonism remains demonstrable in the blood in typhoid fever many months. In scarlet fever, measles, small-pox, and such diseases, it lasts in the body more or less throughout life, so that second attacks are not common, and third attacks are rare. In plague one attack, for a certain time, more or less protects from a second attack, and this fact, noted centuries ago, is the foundation of the present "prophylactic inoculation" methods. The word "prophylactic" merely means "preventive."

**Haffkine's Prophylactic or Preventive Inoculation.**

This is the substance lately used in Sydney to the extent of 10,000 doses, each dose equal to $1\frac{1}{4}$ teaspoonful, injected under the skin by syringe and hollow needle (hypodermic syringe). This is something quite different from vaccination—in the latter one induces a real disease, cow-pox, which is probably an attenuated or weakened and changed small-pox. In anti-plague inoculation no disease is produced—certain materials are merely introduced into the body, just as a medicine would ordinarily be injected. The prophylactic consists of the dead bodies of the bacilli with their products, and is made by sowing real plague bacilli in a sort of meat soup, and after they have been allowed to grow some six weeks it is heated for one hour at 158° F. to kill the bacilli. A little carbolic acid being added, the prophylactic is ready for use. Similar

preventives have been produced as against Asiatic cholera and typhoid fever.

The whole subject of this prophylactic has recently been made the subject of a searching inquiry by the Indian Plague Commission, part of whose report is just to hand. They say that no serious ill-effects have been found to follow the inoculation, and that is our experience in Sydney—plenty of sore arms, I grant, for I have seen them among the 232 inoculations done by myself—local inflammation with general uneasiness or indisposition—but everything quickly passing away, leaving no ill-consequence. The Commissioners conclude that not only are cases of plague at least four times more numerous among the uninoculated than among the inoculated, but also that, when the plague does attack the inoculated, it is much less fatal than amongst the uninoculated, of whom by comparison ten times as many may die. The Government of India has now officially recognised the value of the process. Many in Sydney have been disappointed with the circumstance that even inoculated persons may and do catch the plague, thinking that inoculation should confer absolute immunity or security. Plague itself does not do this! The protection does not establish itself for a few days and lasts for at most a few, perhaps up to six, months, but precisely how long it is as yet impossible to say.

If dead bacilli are inoculated into an animal in sufficient doses they will act as poisons and kill it, but when inoculated in smaller doses, while the animal may be very ill, it will recover. After such recovery it is found that doses of virulent living bacilli, which would kill an uninoculated animal, may be introduced into the inoculated one with more or less impunity. The dead bacilli have led to the protection of the animal as against the attack of the living ones. This protection, however,

does not extend to the action of the products of the bacilli or "toxines," which if injected are found to be as active as ever.

The toxines may be obtained separately from the microbes, just as the snake's poison may be obtained separately from the snake. If injected into an animal in sufficient doses they will kill it; but if in less than fatal doses, while the animal may be made ill, it recovers, and now a larger dose may be safely administered, and so on, dose after dose. The toxines by leading to the development in the animal's body of "antitoxic" substances, confer protection against their own action. As well as in the bacilli themselves, these toxines are contained in the soup in which the bacilli have been grown.

By keeping both the dead bacilli and the toxines in the prophylactic, Haffkine diminishes the "incidence" or relative number of cases among the people, as well as the "fatality" or number of deaths among the attacked. The prophylactic, if it does not succeed in killing the germs, and in thus preventing the attack, will at all events combat their poisons and tend to cure the patient.

In such experiments on animals the preventive is injected into an animal—rat, mouse, guinea-pig, monkey, &c., and in due time a virulent culture of the bacilli is injected into the protected and also into an unprotected or "control" animal. The protected animal, though it may be very ill, will survive while the control dies.

If the protection is established there must be some manifest effect or "reaction" produced when the protective is injected; there is a general effect—fever, headache, discomfort, &c., but also a local effect at the seat of the injection. The general effect passes away in one or two days usually. The local effect lasts four or more days—there is inflammation, hard swelling, redness, and pain. It has been shown that the protective or immunising

effect bears a direct relation to the reaction, so that persons who have suffered much may reflect that they are much protected. When successive doses are injected the resulting reactions are successively less, owing to the immunity established by the preceding doses. A second inoculation is therefore advisable and does not cause so much inconvenience as the first.

As an actual example of the value of the preventive, we may take what occurred in Hubli, a town in the Dharwar district of India, in the week ending 26th August, 1896. The attacks were among the

| | | |
|---|---|---|
| Uninoculated | ... ... | 1 in 9 |
| Once inoculated | ... ... | 1 in 299 |
| Twice ,, | ... ... | 1 in 755 |

Thus, instead of there being over 4,000 cases, as there would have been without any inoculation, there were under 40, and these even had milder attacks, and there were fewer deaths among them.

### Yersin's Anti-plague Serum.

This serum is the liquid part of the blood of a horse, into which gradually increasing doses of the bacillus have been injected, the horse being employed mainly in order to get a large quantity of serum. As the dose of bacillus is increased, the horse, owing to the development of anti-toxic substances, gradually tolerates more and more, until, finally, a small quantity of its blood serum injected into a plague patient tends to cure him, and injected into persons exposed to infection tends to prevent their being infected. By itself the serum is quite innocuous. The efficacy of the serum varies according to how it is produced. If living and virulent bacilli are injected into the horse, the serum is more powerful than if dead ones are injected. Of the first 26 cases treated, in 1896, only 2 died. The succeeding cases were not so successful,

because, owing to the danger attending the injection of virulent living bacilli, the danger of disseminating the disease, dead ones only were employed, and the serum obtained was not so powerful. The preventive action begins almost immediately, but unfortunately lasts not longer than fourteen days. The curative action is immediate but passing, so that on the whole large quantities of the serum are required for repeated injections to keep up the effect. Recently, however, Yersin has inoculated 33 cases and only 14 died, while at the same place, Nha-Trang, 39 uninoculated all died. So great was the virulence of the disease, so little the power of resistance to the plague of the Annamese, yet, in spite of this, not one person preventively inoculated took the disease. At Oporto last year, where the serum was prepared first with dead, then with living, bacilli—the mortality was reduced from 63 to 15 per cent. The germicidal action of this serum has been directly proved—a drop of plague blood sown on jelly before the injection gave 32 centres of microbic growth, after a first injection only 2, and after a second none at all. These actions are now readily understood—the serum is "antimicrobic" or "germicide," *i.e.*, kills the bacilli, and "antitoxic," *i.e.*, neutralises their poisons or "toxines." In the same way "antivenene" is produced in the blood of horses injected with gradually-increasing doses of snake venom. The rigid proof of these actions in the living body is simple: the fatal dose of the plague bacilli is found simply by experiment—if the anti-plague serum is injected before the fatal dose of bacilli, the animal does not become so ill and does not die; if injected after the plague bacilli and when the animal has already become affected, the recoveries are more numerous than in the uninjected.

As to the risk of conveying disease from the horse to the human subject, there is no evidence of anything of

the sort. Glanders is the equine malady of which one first thinks, and as we have a test for that, "mallein," the little risk there is of that disease escaping the skilled veterinarians and medical men during the long time of the horse's treatment is reduced to nil. Tuberculosis also cannot well escape detection. For it we have the "tuberculin" test.

The horse yields much serum—one horse has yielded at different times antitoxic curative serum for in all 1,850 persons suffering from diphtheria, and is fat and well. May it live for ever!

### Combined Yersin and Haffkine Injections.

If an animal be injected with Haffkine's prophylactic and at the same time with living bacilli, it is found that a smaller dose of bacilli will kill than if no Haffkine had been injected. This has been adduced against Haffkine's method. It is thus explained: Haffkine's fluid produces at first a slight poisoning of the system, and this, added to that produced by the bacilli, produces a combined result, so that a smaller dose of the bacilli than usual may be fatal. The only danger in using Haffkine's fluid then is, that the person inoculated may be actually developing the disease at the time of his inoculation. The expedient which may be adopted to avoid this danger is to inject first a small dose of Yersin's anti-plague serum, and to follow this in two days with the Haffkine; the first at once begins to give protection, which lasts up to, say, fourteen, or even more, days, while the protection due to the latter is established in, say, eight days, and lasts, say, six months. Calmette has suggested another plan, viz., injecting Yersin's serum, to which dead bacilli have been added; but the results are not yet published.

### The plague preventive as a dry powder.

It is now claimed by some (Lustig and Galeotti, of Florence) that they can extract the protecting substances from the bacilli and keep them indefinitely long in the dry state—such a powder not being subject to contamination nor decomposition, and, definite doses being weighed out for each case, some of the difficulties of Haffkine's fluid are avoided.

### Prevention of Plague. Some General Remarks suitable for the time.

When plague appears it is always well to prepare for the worst; it is impossible to predict its course, and it may be calamitous. Even with all our efforts it has not been stamped out in India, and there are some who think that very little impression has been made upon it! But our newer knowledge as to the influence of the rats may change all this, and there is good hope that it will. So far as we can see, and as already said, the outbreak lasts from seven to eight months, or until the disease becomes more or less chronic among the rats, then it is in abeyance among them until a new lot of rats arrive, and then it breaks out again, first among them and then among men. We must thus reckon upon four months more of the present outbreak and be prepared for another one next year. We must, therefore, continue diligently to seek, find, kill, and destroy the rats all the time, as well in the healthy zone as in the infected area. This is what the best knowledge of the day enjoins.

Undoubtedly the schemes for a greater Sydney should be carried into effect. In no other way are we likely to get sufficiently paid and competent officials, who can and will do their work.

The Health Department should be fostered. Medical Officers of Health and Inspectors of Nuisances must be properly educated, properly paid, and have a secure tenure of office, putting them beyond the influence of the local magnate. An island in the harbour, such as Goat Island, should be immediately set apart and fitted up as a station for working with plague and such like organisms, and for making prophylactic and serum, including anti-diphtheritic serum, and the serum that cures tetanus or lock-jaw, and for much other work of the same kind.

The Municipalities must raise money to carry out sanitary measures. When these are required one is always met with the same answer, "No money." It is true, but they must be empowered to raise the money for sanitary purposes as they do in the old country, and you must be prepared to pay it.

A proper Building Act is imperative, and architects must be educated, examined, and licensed just as lawyers are and doctors ought to be. The bad architect is the rat's friend and man's enemy. A badly-constructed house is an asylum for rats, and once infected is difficult to disinfect. The best defence of a town against plague, therefore, is to have its buildings rat-proof. Moreover, it is our only complete defence, for no one has ever yet succeeded in exterminating the rats when once they have established themselves in a large town.

Animals in the City.—Keeping these in the city should certainly be under some restriction. A most trustworthy man told me that he once counted thirty-six goats in view at one time in the city in the Haymarket district. Personal inspection has revealed to me how frequently poultry is kept in the back yard. The goats, although they *are* the poor man's cows, and the poultry I would abolish altogether. Horses are a

difficulty—they must be kept not too far away, but they should be kept clean in properly-constructed stalls—especially should the floor be impervious to moisture, the stable connected with the sewer, and the manure kept in covered pits, and frequently removed therefrom. Cows are already, to some extent, under inspection, but I am afraid far from vigorous enough. With our present facilities for bringing fresh milk from the country, I do not see any real need for tolerating cow-houses any longer in such inhabited places as Sydney.

While we thus undoubtedly require some new legislation, we require this much less than the vigorous enforcement of acts already in force, in which are contained abundant provisions for the care of the public health. I refer especially, of course, to the Public Health Act and the Noxious Trades and Cattle Slaughtering Act passed when I was President of the Board of Health, and in the framing of which I took a great part.

In Sydney nature has provided us with abundant sunlight and fresh air, abundant food and water, and in a new country a sufficient space should not be so unattainable. God has made the situation of Sydney beautiful—let man make and keep the City beautiful *and clean.*

NOTE.—I have published this lecture, which was first delivered at the Young Men's Christian Association Hall, at the suggestion of the Premier, Sir W. J. Lyne, K.C.M.G., who kindly writes a few words by way of preface. In writing it I have consulted the writings of Batzaroff, Bourges, Calmette, Creighton, Ferré, Hankin, Hecker, Hirsch, Netten Radcliffe, Payne, Salimbeni, Simond, Tidswell, Yersin, Zabolotny, and others. I have copyrighted the lecture so that I may control people who might otherwise use it for purposes of trade.

—A.S.

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