

PLAGUE : ITS EXCLUSION AND CONTROL.

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IN the case of an exotic disease, such as plague, our first care is necessarily towards exclusion, and it is not until its introduction has been permitted that we become directly concerned with its control.

The measures which have been laid down as essential include :*

1. *International Notification.*—This would come too late (if anticipatory measures had not been taken), “as it is not customary to notify the presence of plague unless there is good reason to consider it epidemic,” and, a point of extreme importance, “the notification regards exclusively *manifestation of the disease in man*. This, we have learned, is a matter of secondary importance, it has been preceded by the epizootic, and the real danger to the importing country lies with the plague rat, not with plague-stricken man.” And even the notification of rat plague would not remove the uncertainty of reliance upon the action of other countries, or the very great and practically insuperable difficulty of destroying rats amongst the full cargoes.

2. *Arrest of Infected Persons and Things.*—This is naturally a measure of importance, and has up to the present received the largest share of attention. The regulations to this end seem to leave little to be desired.

3. *Destruction of Rats Afloat.*—This point, though admitted on all hands as necessary, has received far less practical attention than circumstances warrant, and deserves consideration in some detail. I do not think I need dwell with too much emphasis upon the importance of the rat as an agent in the transmission of plague over sea. Some causal relationship of the rat to plague epidemics has been noted in every country affected from China and India to Australia and Central Africa. The nature of this connection is made abundantly evident in the instructive article (Article IX.) in the *Quarterly Review* for October, 1901, as well as in the Sydney report quoted above. But in all instances previous to 1898 the rat infection has been regarded as an accompaniment of human plague of merely secondary interest, and precautionary measures

* Dr. Ashburton Thompson, “Report on an Outbreak of Plague at Sydney, 1900,” by the Chief Medical Officer and the President of the Board of Health, Sydney. William Applegate Gullick, 1900, Government publisher.

have been designed entirely or chiefly to meet the circumstances of human infection.

On July 7th, 1898, Koch stated before the German Society of Public Hygiene* his belief that plague was *primarily* a rat disease existing in certain endemic centres in India, China, Arabia, and Central Africa, and that it only became *secondarily* epidemic amongst persons. The cause for its endemic persistence in certain localities may be, as suggested by Cantlie,† dependent upon the distribution in these areas of a peculiarly susceptible sub-family of rats.

Manson, in 1899, at the opening of the London School of Tropical Medicine, insisted upon the necessity for dealing with plague as essentially a rat-borne disease, and of adapting our repressive measures to newly ascertained conditions instead of moving blindly along haphazard routine lines sanctioned by tradition and custom, but inapplicable to the end in view.

Koch has more recently, at the Tuberculosis Congress in 1901, reiterated his former belief, and has stated the problem in explicit language thus :

“The most important lesson we have learned from experience is that it is a great blunder to treat pestilence uniformly. This was done in former times, no matter whether the pestilence in question was cholera, plague or leprosy ; isolation, quarantine, useless disinfection, were always resorted to, but now we know that every disease must be treated according to its own individuality, and that the measures to be taken against it must be most accurately adapted to its special nature, to its etiology.”

“Bubonic plague may be instructive to us in several respects. People used to act upon the conviction that a plague patient was in the highest degree a centre of infection, and that the disease was transmitted only by plague patients and their belongings. Even the most recent international agreements are based upon this conviction. Although we can now recognise plague with certainty, and although the prescribed inspection of ships, quarantine, the isolation of patients, the disinfection of infected dwellings, of ships, are carried out with the utmost care, the plague has nevertheless been transmitted everywhere, and has in not a few places assumed grave dimensions. Why this has happened we know very well, owing to the experience quite recently gained as to the manner in which the plague is transmitted. It has been discovered that only those plague patients that suffer from plague pneumonia—a condi-

* *British Medical Journal*, July 16th, 1898, p. 205.

† “The Spread of Plague,” *Trans. Epidem. Soc.*, New Series, vol. xvi., pp. 18, 19.

tion that is fortunately infrequent—are centres of infection, and that the real transmitters of the plague are rats.”

“There is no longer any doubt that in by far the majority of cases in which the plague has been transmitted by ocean traffic the transmission took place by means of plague among the ship rats. It has also been found that wherever the rats were intentionally or unintentionally exterminated the plague rapidly disappeared, whereas at other places where too little attention had been paid to the rat plague the pestilence continued. This connection between the human plague and the rat plague was totally unknown before, so that no blame attaches to those who devised the measures now in force against the plague if the said measures proved unavailing.

“It is high time, however, that the enlarged knowledge of the etiology of plague be utilized in international as well as in other traffic.”

The belief thus strongly stated by Koch is the belief which through recent experiences has been crystallizing in the minds of many, that plague is primarily a disease of rats, and that a thorough and practical appreciation and application of this fact is the key to prevention of the disease.

A curious fact observable in almost every part of the world has been the passive resistance offered by the official as well as the public mind to the application of this fact, and an apparent disinclination to take precautions in anticipation against a new form of danger.

It is possible that some of this inertia is due to the failure of the Indian Plague Commission in the very home of plague to obtain a practical grasp of the relative importance of the facts as to rat infection—a failure due, no doubt, to the impossibility amid Asiatic surroundings, and in the face of a huge and established epidemic, of distinguishing with any degree of exactness between cause and effect.

No sooner, however, had plague attacked a civilized Western population at Sydney than the facts as to the relative position of rat and man in the introduction and spread of bubonic plague became for the first time obvious and indisputable.

Remarkable as it is that we can point to no nationality that has adopted efficient precautions against rat infection in anticipation, the unanimity with which these are becoming adopted and urged after actual experience of plague is very significant.

In the early part of 1900 Sydney passed through an outbreak of some 300 cases of bubonic plague* which was obviously introduced

* *Op. cit.*

by rats, and spread by rats, and in which direct infection from person to person was demonstrated under reasonable conditions of decent housing to be a negligible quantity. This outbreak also rendered clear the right preventive meaning of a plague "contact" as one who had been exposed within the incubation period (two to ten days), not to human, but to rat infection.

AVAILABLE MEANS TOWARDS EXCLUSION OF PLAGUE.

It will be instructive to consider the means available towards exclusion of plague from English ports, and how far they are satisfactory.

1. *The Plague Regulations of November, 1896.*—These Regulations provide very completely for dealing with any actual cases or suspected cases of human plague arriving on board ship, and, so far as the risk of introduction from such cases or their belongings is concerned, they appear to be admirably adapted to the purpose.

Owing to the incompleteness of our knowledge at the time they were issued they unfortunately ignore the very grave risk of the introduction of plague through infected rats, a risk especially present in the case of grain-boats or cotton-seed boats coming from infected ports.

2. Two Memoranda have since been issued by the Local Government Board: the first, a General Plague Memorandum, under date September, 1900; the second, a Special Memorandum on "Ship-borne Plague and Rats," under date April, 1901.

The first of these, while pointing out in section (4) that there can be no doubt that the rat and man are reciprocally infective, and that in threatened or invaded districts rats should be promptly destroyed, deals rather with the *control* of plague than with its *exclusion*.

The second Memorandum specially advises sanitary authorities of seaports to be on the alert to prevent introduction of the disease into their districts by the importation of plague-infected rats, and for this purpose suggests:

Sec. 1. On the arrival of a vessel with plague or suspected plague on board that the rats on board should be destroyed, and meanwhile that the ship should be moored off shore, and the cables guarded.

Sec. 2. In the case of vessels from infected places, but without human sickness on board, that inquiry as to rat mortality be instituted, and if plague mortality amongst rats be proved, the subsequent adoption of similar precautions.

Sec. 3. That any exceptional rat mortality be similarly dealt with.

Sec. 4. That rats should be cremated without handling.

Sec. 5. That every ship with infected rats be disinfected.

Sec. 6. That town rats, especially in docks and quayside warehouses, be destroyed, shore rats prevented from going on board ship, and an attempt made to destroy all rats on board ships about to proceed on their voyage, the captains being persuaded to take steps for the destruction of rats that may have remained alive notwithstanding the action of the local authority.

While this Memorandum gives the sanction of official approval to efforts at exclusion of ship-borne rats, it is unfortunately not compulsory, so that it has rather the force of a "pious opinion" than of a Government Regulation. No penalties attach to non-compliance or disobedience. Without wishing to consider the Order in any carping spirit, it is unfortunate that the precautions as to off-mooring of the ship and guarding of the cables, to which might well be added uplifting of gangways at night, and the employment of day and night watchmen, are not prescribed as necessary until after confirmation of the existence of rat plague, which necessarily takes some time. In the meantime the very event it is so necessary to prevent—communication between sick and healthy rats—may have happened.

The issuing of this Order has, however, to a large extent facilitated port methods of prevention, and may be accepted as provisionally useful pending the possibility of securing more complete and adequate Regulations.

The methods which are practically in use in the port of Bristol, and, I believe, in most other large trading ports, are as follows:

1. The weekly lists issued by the United States Marine Hospital Service are consulted as to infected ports, and form the basis of the local list, supplemented from time to time by telegraphic news in the London papers and private information.

2. A port once definitely infected is kept on the list for at least three months after the official clearance, which is based upon the cessation of the human group of cases. This is, of course, fallacious, as human cases of plague in a freshly invaded district are, after the first introductions, probably only the visible fringe of an invisible epidemic amongst the rats, of the progress of which we have no means of obtaining reliable information.

3. From all suspected or infected ports, boats, especially grain and cotton-seed boats, are at once on arrival treated as "suspect,"

moored 6 feet off shore, with cables guarded and gangways up at night, and day and night watchmen employed, so that, if plague rats are found to exist on board, they have had, in the meantime, as little chance as possible of gaining shore.

Happily, these precautions had already been three months in force when in January, 1901, a grain-boat from Smyrna arrived at Bristol, and, being quite free from human sickness, came right up into the mid-city harbour, within a stone's-throw of the public health offices, and amongst grain-warehouses and dwellings. Thirteen rats in the forehold were found dead of plague, as described in the *British Medical Journal* for August 10th, 1901. I was much impressed by the immunity enjoyed by the crew, an immunity common in these importations, as the crew do not necessarily come much in contact with the holds, which are discharged by gangs of shore labourers.

But this occurrence brought into strong relief the weakness of the available methods towards *exclusion* of plague, and convinced me that the permitted transportation of droves of rats from port to port, from infected port to healthy port, and back again, is, from the point of view of common-sense preventive medicine, little less than a fatal error.

In the case quoted fumigation of the vessel destroyed 226 rats.

Can one conceive any enlightened nation permitting packs of dogs with rabies (which is, in its reciprocal relations with human hydrophobia, comparable with plague) to be carried about unchecked from port to port, while elaborate medical inspection and hospital provision for the human victims of hydrophobia are carefully provided, contacts with human cases of hydrophobia are solemnly quarantined, and certificates of clearance for infected ports are gravely granted on the basis of the progress of human cases?

And yet this is analogous to what is at present permitted in the case of plague by every nation that has not as yet had actual experience of the disease.

THE POLICY OF RAT-FREE SHIPS.

The present policy of allowing the approach of rat-infected ships, and then attempting to prevent the rats coming ashore, is surely attacking the evil at the wrong end. If possible, the obviously correct method would be to insist upon the destruction of all rats in ships when empty, and upon the subsequent observance of precautions to prevent the entry of more rats when loading at infected or other ports.

It is necessary to inquire whether this is a counsel of perfection, or is likely to cause undue interference with trade, and the experience of Australia supplies us with the necessary encouragement.

Dr. Ashburton Thompson assures us in his report on the Sydney outbreak that this practice is not difficult to secure. He states that, if vessels which engage in coasting voyages lasting three weeks to a month are fumigated at the point of departure *before loading*, and at the ultimate port touched on the voyage, few and often no rats are discovered to remain, and this statement applies to steam-vessels of various tonnages up to 4,000. This method, he further states, has been practically carried out under inter-colonial agreement, which requires vessels to produce a certificate of fumigation, without which they are liable to detention.

Turkey is the first of the European nations to follow these obvious lines of intelligent prevention. The measures adopted by the Constantinople Sanitary Board,* and shortly to be enforced unless too great pressure is brought to bear against them, exact that vessels coming from a port infected with plague must be provided with a certificate of "rat destruction." A ship from a contaminated port without such certificate will be compelled to go to a lazaret and have its rats destroyed. As this can only be effectually done when the vessel is completely empty this will necessitate the discharge of the cargo into lighters, the destruction of rats in the empty vessels, and the subsequent reloading to enter the port and discharge, obviously meaning an enormous loss of time and money.

No such expensive procedure would, however, be necessary to secure the destruction of the rats in empty vessels before loading, and as this method has been found practicable in Australia there is no reason why it should not be systematically enforced by the European nations.

There are signs that the commercial world in England would willingly accept reasonable measures designed to this end.

The Bristol Chamber of Commerce, after an interview with the Health Committee, decided that it was in the interest of commerce to adopt what I have called the policy of rat-free ships, and accordingly the following resolution was proposed by Bristol at the 1901 meeting of the Associated Chambers of Commerce at Nottingham, was seconded by Greenock, supported by Halifax and Southampton, and carried by an overwhelming majority :

"That, as it appears desirable in the interest of the public health to minimize opportunities for the introduction and

* *Board of Trade Journal*, November 21st, 1901, p. 367.

dissemination of diseases by ship-borne rats, it is of importance that regulations made for this purpose should be so framed as not injuriously to affect the trade and commerce of the country. This Association therefore recommends that the captains of vessels loading at plague-infected ports should be ordered to destroy rats on board ship before loading cargo, and to take precautions to prevent rats getting on board during the time cargo is being loaded, and that British consular certificates should be issued to captains obeying such orders. The Association further resolves that a copy of this resolution be sent to the Board of Trade and the Shipowners' Association."

On December 19th the secretary of the Bristol Chamber of Commerce reported that a copy of the resolution had been duly forwarded as suggested. The General Shipowners' Association replied that they would themselves have issued a circular to this effect had not the port of London already issued one. The instructions issued by the port of London leave little to be desired, but they lack the force and authority of Government Regulations with attached penal clauses; and it is difficult to understand why the Shipowners' Association should have considered the issue of regulations by any one port sufficient to prevent the necessity of concerted action over the whole country. I fear they have entirely failed to grasp the gravity and urgency of the position, and look upon rat-borne infection as a possible, but rather unlikely, event; too well established to be altogether neglected, but too little important to receive urgent attention.

The Board of Trade, for their part, replied that they were in communication with the Local Government Board; nothing further has resulted up to the present.

Since I read the remarkable and convincing report of Dr. Ashburton Thompson, of Sydney, and after an actual experience of the reality and risk of rat-borne infection in Bristol, I have endeavoured, at Liverpool in March, and at Hull in October, before the Association of Port Sanitary Authorities, as well as at Cheltenham in August before the British Medical Association, to obtain a recognition of the position, and forward the securing of regulations towards rat-free ships. In each case a unanimous vote, similar in scope to that of the Chamber of Commerce quoted above, has been adopted.

The Incorporated Society of Medical Officers of Health has also forwarded a memorandum on this subject to the Local Government

Board.* The matter seems to me urgent enough to demand determined and speedy action, if the Western nations are to escape the reproach of permitting the introduction of a disease by neglect of simple, well-defined and obvious measures of true prevention, which by securing "exclusion" may prevent the necessity for "control."

CONTROL OF PLAGUE.

The necessity for control involves the permitted introduction of the disease. If "exclusion" fails the points to be considered are well laid down by Dr. Ashburton Thompson (*op. cit.*). They are :

1. Care of sick, including the provision and maintenance of hospitals.
2. Care of contacts, who are not necessarily those who have lately been associated with a plague patient, but more frequently those who have been exposed in more or less close association with plague rats.
3. Protective inoculation.
4. Exclusion of rats from dwellings and from the immediate neighbourhood of dwellings or work-places.

Careful instructions have been issued by the Glasgow Health Committee, and similar instructions by the Bristol Health Committee, detailing the importance of making the basements of dwellings secure against rat invasion. In Bristol, also, the Sanitary Committee have instructed their engineer to pay special attention to old stone sewers which may be known or suspected to serve as rat-runs and breeding places.

5. Destruction of rats.

In Australia the destruction of rats in sewers, warehouses, and dwellings is laid as a special duty upon the local boards of health, and penalties are laid down for non-compliance with instructions they issue.

6. Destruction of human parasites.

An important point, as probably the flea is the necessary intermediary between the rat and man in the transmission of the inoculable bubonic plague.

7. Cleansing and disinfection.

General Sanitary Conditions.—Attention to the general sanitary conditions of a district invaded by plague finds little part in these precautions, except so far as sewer or drain defects in connection with basements permit the access of rats to inhabited places.

* PUBLIC HEALTH, vol. xiii., p. 517.

General sanitary conditions need the continuous attention of local authorities, and the value of due attention to this point will be evident at all times; it is necessary, however, to be mindful of Koch's definite warning, and not to confuse issues by ascribing too great influence to what may be only accompanying circumstances.

It may, no doubt, be true that plague has never spread except amongst grossly insanitary conditions of life. This is more or less true of all communicable diseases, but it must be remembered that all such diseases are not "filth" diseases, and that even "filth" diseases have their selective methods of spread; while the fact that gross insanitary conditions are allowed to exist in itself suggests that other administrative measures are correspondingly defective, and explains much of the constant association between the existence of such conditions and the extension of epidemic disease.

DISCUSSION.

Dr. ASHBURTON THOMPSON (Sydney) said that he would only emphasize one of Dr. D. S. Davies' points—namely, that the only way to avoid world-wide diffusion of plague rats was to keep all ships habitually free even from healthy rats. He would illustrate this necessity by reference to the case of the s.s. *Antillean*, which arrived in the early part of last year at Sydney carrying a deck-hand who was suffering from plague, and on which plague rats were also found. This vessel left Southampton at the end of 1899; she was a transport of about 4,000 tons, chartered by Government. She proceeded to China, and for many months carried military and other stores between several ports. About August, 1900, she was ordered to Cape Town, and performed similar service on that coast until the end of January, 1901. On February 1st she left Cape Town for Sydney, whence she was to take mounted troops back to the Cape. She arrived on March 2nd under the circumstances just mentioned. Now, plague was not known to be present at any of the ports of South Africa at which the *Antillean* touched in the course of her service until after she had left Cape Town. Plague was reported to have appeared there in man about February 9th, 1901, but prior to that date no suspicion of presence of this infection was entertained. So far, then, the case showed that a vessel might leave a port at a time when everyone supposed the latter to be clean, and yet might have received the infection of plague there, and might carry it to a clean port, at which latter she would—or, under probable circumstances, might—receive free pratique on arrival, and go alongside. He hoped that the full details of this case would be made available through the columns of the journal as soon as he was able to forward his official report upon it. In the meantime, he would merely mention a further point brought out by it. It was that plague introduced among a moderate number of rats on board an empty vessel spread among those animals so slowly that, out of from 100 to 120 rats with which it was believed on good evidence the ship started, eighty-three still survived, and were killed at the port of arrival; while some of them were actually suffering from plague at that date, although the voyage had lasted no less than twenty-nine days. That was a very striking demonstration of the fact that plague does not always spread rapidly among rats. In view of the way in which this

disease appeared to hang about infected localities, and year after year became epidemic again without any apparent reason, that was a very important fact to the epidemiologist. Simond (*Annales de l'Institut Pasteur*, 1898) had drawn this inference from his Indian experience, and the case just related appeared to show that he was quite right. So that, unless all ships were kept habitually free from rats, it was certain, for the two reasons just given, that attempts to prevent oversea carriage of plague rats must from time to time—he thought most often, in all probability—fail. His experience showed him that this could be effected to a useful extent by fumigation with burning sulphur, done as was described in the report on the Sydney epidemic.

As he was at one with Dr. Davies on the points mentioned by him, he would not further refer to his paper, but would take the opportunity of drawing attention to the circumstances under which the Sydney epidemic had been observed. In the first place, he would express the opinion that epidemiological work was done in countries densely inhabited by Asiatics under very great difficulties—was, in fact, impossible, except under special aspects, and when co-operation of the people themselves was not requisite. That was to say, that some broad facts as to locality and the like could be gathered with more or less accuracy, of which Mr. Hankins' paper in the volume of the annals already cited was a good example; but attempts to ascertain the mode of spread among such a population were foredoomed to failure. Secondly, he was aware that, when persons read or heard of a distant city which they had never visited, they were very likely to entertain a vague notion that it was "foreign," and this was especially the case if it were necessary to mention even a very small sprinkling of coloured people among the white population of the city. He thought that such an idea was, consciously or unconsciously, sometimes entertained of Sydney, where there was a proportionately quite small colony of Chinese—about 4,000 or less to about 500,000 whites. He would therefore say that, so far was Sydney from resembling a foreign city, that those who had never seen it would form the best idea of it if they imagined it as an English town. The climate was somewhat different, it was true, but housing and habits were exactly the same as in England; so, also, was clothing, according to the season, and food. What he desired to point out was a direct consequence of this. It followed that the circumstances, being the same as in England, allowed epidemiological work to be done in exactly the same way as in England. The phenomena of the recent plague epidemic could be observed with all the particularity and exactitude with which epidemics of typhoid fever, small-pox, or diphtheria had so often been observed here. Now, it followed necessarily that, if the Sydney epidemic were so observed—and his report furnished them with the means of judging—the conclusions arrived at must be allowed very much more weight than conclusions reached under the essentially unfavourable circumstances of China or of India to which he had referred at first. He might be considered to be unavoidably prejudiced in favour of observations made by his own staff and under his own direction. However that might be, he had no hesitation in saying that he was unable to concur in the opinion formed by the Plague Commission in India, nor with the impression conveyed by the article in the *Quarterly Review* for October, 1901, to which Dr. Davies had referred—namely, that the infection of plague was very commonly carried in fomites, and, as it appeared, that spread of the infection by fomites was a most frequent starting-point of epidemics in towns previously free from the disease. At Sydney it could be said not merely that there was no evidence of indirect communication of infection from the sick,

but that positive evidence was got that the infection was not communicated in that way. For similar reasons he had no notion that epidemics were caused by direct communication of infection from the sick, though doubtless individual cases were sometimes so caused, nor that the infection clung to houses, nor that it rested or grew in the soil, and thence infected fresh victims. A distinction should be carefully drawn and constantly borne in mind between occasional causes of infection and those which operate so constantly as to cause epidemic prevalences. These were conclusions which had most important practical bearing on the work of control, in which medical officers of health would be largely concerned. Whether he was justified in relying thus strongly on the result of the Sydney observations or not, they must judge for themselves from the various records.

[Subsequently Dr. Ashburton Thompson addressed the following remarks to the Editor :

Having been asked to speak first at the meeting, I had no opportunity of joining in the discussion proper, which was protracted. But one point attracted my attention, and it is of so much importance that I might perhaps be allowed to remark upon it. I noticed that several gentlemen spoke of Simond's theory of spread of the infection by fleas as though it were a well-established fact. It should be remembered that there is in reality no direct evidence of it, except the results of Dr. Simond's own very few experiments, which may admit of some other explanation ; while, on the other hand, Dr. Nuttall has failed to convey the infection of plague, and of several other diseases, from animal to animal by agency of insects. Dr. Nuttall's series is a very long one, and this to some extent discounts the negative character of his results. On the other hand, the experiment manifestly is one very difficult to control. The case stands thus : *B. pestis* was discovered by Simond in the digestive organs of fleas taken from rats which were dying or had died of plague. This we corroborated in our laboratories, Dr. Frank Tidswell having identified the bacillus in narcotized fleas removed from plague rats, and, after crushing one such flea in distilled water and inoculating the mixture into a guinea-pig, he saw the latter animal die with all the clinical and post-mortem signs of inoculated plague. The bacillus was therefore not merely viable, but virulent. That is one well-established fact. Referring next to plague in man, it is found occasionally that at some part of the area which drains through the lymphatic ganglion which has furnished the mother-bubo there is a phlyctenule surmounted by a minute vesicle, or a very small bleb. In the contents of these small vesicles (which resemble those sometimes produced when experimental inoculation is performed with a needle) the bacillus has been demonstrated by Simond and others, as well as by ourselves, and, all things considered, the opinion that they have resulted from punctures made by a suctorial parasite seems justifiable. But there is an all-important hiatus between these two observations. There is no direct evidence at all that the puncture which has resulted in a phlyctenule actually was made by a suctorial parasite carrying (on its beak or elsewhere) the bacillus of plague. On this topic I believe I have previously expressed myself with insufficient fulness. I should like to say, therefore, that I accept Simond's view merely because it brings into accord or explains many observations concerning plague which are not explicable, as far as I can see, on any other hypothesis hitherto suggested. I accept it as a working theory ; I think it is very probably the truth. I am prepared to hear that direct evidence of its truth has been obtained, but for the present such evidence is still to seek. Yet I can hardly conclude with that. I

must point out, what those who have read our account of the first case of plague which occurred at Sydney must have noticed, that we had definitely accepted this theory of the spread of plague from rats to man by intermediation of parasites before the disease had appeared among us, and had selected it as the one by which we should guide our course if plague should invade us; that in that very first case we detected a bleb such as I have spoken of above; that we forthwith inferred there were plague rats somewhere in Sydney, and by advertisement and otherwise immediately sought them; that we were justified by the event; and, lastly, that in the epidemic prevalence which established itself about a month afterwards we found this a serviceable guide, and in the whole course of a long term of laborious observation met with no phenomenon which it did not easily explain. This is not the rigid proof, obtained under the controlled and fixed conditions of the laboratory, which is always to be desired, and yet, after making myself acquainted with a very great deal of the mass of writings about plague in various countries which has now been published, I see no good reason for seeking any other guide to prevention than this theory of its mode of spread in epidemic form.]

Dr. FARRAR wished to endorse the very valuable paper of Dr. Davies. With regard to his remark that Indian people lived under insanitary conditions, his experience was that that was not generally the case. They washed much more often and more thoroughly than did English people. They lived more in the open air. They wore fewer clothes, and kept them cleaner. This emphasized what he wished to say about the spread of plague among the Indian people. It was generally said among the plague officials in the town that if they wished to be free from the infection of plague they had better go to the hospital, which was the one place in the city where they were least likely to catch plague. As far as his experience went he did not know of a single case of a nurse or attendant or doctor or any member of the staff contracting plague, and they had not been inoculated. The reason why the natives contracted the disease and the British did not was simple: the natives were a bare-footed people; all the lower classes wore toe-rings, and most of them had sores under the toe-rings, and they picked up infection from the ground. There was undoubtedly infection in the soil, probably spread there by rats, because they had strong evidence of the epidemicity of plague among rats in Poona at the same time. With regard to the treatment of contacts from a rat-infected ship, he would suggest that the sailors should be treated in a different category from the shod European. To treat an ordinary European passenger in a P. and O. boat in the same way as a Lascar would be absurd. There would not be much difficulty in treating a Lascar as a contact, for they were not very exacting in their accommodation. With regard to the destruction of rats, it was very important that dead rats found on a ship should be promptly plunged into a strong sublimate solution, if only to destroy any bacillus in the fur of the animal, and to destroy the parasites. After the rat had been dead four or five days the fleas left him, and the rat was of comparatively little danger.

Dr. HERBERT WILLIAMS (Port of London) agreed with Dr. Davies in the general direction of his paper. A port officer in preventing plague coming into this country should have certain ideals. First, to prevent vessels coming into the country from an infected port containing rats on board. That could be done in a foreign country by having vessels fumigated. The first difficulty was who should be responsible for this being done. He had very little opinion of the value of a consular certificate that it had been done, and from his own experience

of masters of vessels they were not likely to take much, if any, trouble about such a matter. With regard to fumigation, he had supervised the fumigation of vessels in the port of London by burning sulphur, by using compressed sulphur dioxide gas, and also by the system of an American firm. In none of those cases could it be said they had absolutely destroyed every rat on the ship. In the first place, in burning sulphur it was very difficult to insure the proper combustion of sufficient sulphur to insure the proportion of SO_2 being present necessary to destroy the rats; then, if they used compressed SO_2 , the gas was very heavy, and not easily diffused. It existed in the holds in patches. In a vessel fumigated three weeks ago, for instance, a number of dead rats were found, and a number of rats in a cage were found alive eight or nine hours afterwards, although the cage had been within 6 feet of the cylinder. The company's method was more satisfactory. In a large vessel recently upwards of two or three hundred rats were destroyed, but the master of the vessel said that even then rats were found on board. To destroy every rat on a vessel by the means at present at their disposal was, to a certain extent, impossible. The next ideal was to take every case of actual or suspected plague and isolate it, and to insure that supervision was exercised over all persons on board the vessel during the incubation period of the disease. The third ideal was to destroy every rat in the country. That seemed to him at present to be impossible, and although efforts were made in the docks and warehouses, and large numbers of rats destroyed, it was only like dipping a pail of water out of the ocean.

Dr. CLARKE (Chairman Liverpool P.S.A.) said in the main he agreed with the views of Dr. Davies. In Liverpool they were acting up to these views in a great measure. Not only were they trying to destroy rats on ships, and also those found in docks and warehouses, but they had extended their operations to all spheres under the control of the Corporation, more especially to markets. At the same time, he was not quite willing to admit that human infection was a negligible quantity. No man occupying the position he did would be justified in neglecting such simple precautions, when plague threatened, as maintaining suitable hospital accommodation for the treatment of patients infected with plague, or providing suitable accommodation for those who had been in contact with plague. It was all very well to say that this disease was carried only by rats, but there was sufficient evidence of human infection to warrant their taking steps for the proper reception of patients and the isolation of contacts. Possibly meetings such as that would educate them up to believing that human infection is a negligible quantity, but in Liverpool he believed they were right in adopting all such precautions as they were advised were necessary to secure the exclusion of plague. Liverpool relied as business men on the existence of such precautions; they believed the cost was a flea-bite compared with the expense they would have to bear if plague secured a footing in the Empire.

Dr. HORE (Liverpool) said that in Liverpool they were doing all in their power to destroy rats. He did not agree with Dr. Davies that the reason they had so many rats was because of inertia. He agreed rather with Dr. Williams that few people were more desirous of destroying rats than shipowners, but they had to contend with extreme difficulties. If they considered for a moment the enormous size of modern vessels, the great difficulty of preventing rats running the whole length of the ship while one hold was being fumigated, the trouble would be appreciated. A vessel as large say, as Adelphi Terrace, with huge holds capable of accommodating enormous quantities of cargo, would require very special measures to insure the complete disinfection of so large a space, and the

destruction of the rats contained in it. He quite agreed with Dr. Davies that they should do all they could to insist on shipowners insuring the destruction of all rats infesting a ship, and it occurred to him that the Society might suggest for the consideration of the Local Government Board whether or not that Board would be disposed to supplement the Orders to which reference had been made by a circular addressed to shipowners, advising the measures which should be taken for the destruction of rats on a ship. At present the owner was anxious to be told how to destroy the rats. A circular issued with the weight and authority of the Local Government Board, which not only advised the destruction of rats, but which set out the best means of so doing, would have great value. Another matter was to invite the Local Government Board to consider the advisability of issuing an order authorizing the detention by the port sanitary authority of all vessels coming from infected ports which on arrival were found to be infested with rats, quite apart from the question of disease on board, or even suspected disease, either among humans or rats. The mere fact that the ship was infested with rats should be a sufficient reason for its detention. The experiments described by Dr. Williams had been carried out also in Liverpool. The results had been to destroy the rats so far as they could ascertain, but he thought it extremely probable that in large vessels the rats would find some means of running along the whole length of the ship and escaping from hold to hold as different parts were disinfected. Clearly that method could only be properly applied when the vessel was empty. The use of SO_2 when the ship was laden with coffee or fruit, or other similar cargo, would probably be attended with harm to the cargo. He gathered from Dr. Farrar that he was less disposed to give to the rat and only the rat the possibility of communicating infection than Dr. Davies, who appeared to take it that the rat alone was the necessary medium; but surely the flea could be the means of infection also. It was quite possible that the flea might communicate the disease to a human, and from one human to another. In Liverpool they had found people suffering from plague absolutely free from any direct contact with rats; but it was possible that fleas had been transferred from rats to humans, and had become the means of infection. He could not assent to Dr. Davies' suggestion that sanitation and plague had no connection whatever. If, for instance, they had ashpits, stable middens, and such places overrun with rats, they could not but regard them as contributory to the extension of plague. Moreover, if the rats were in such places, other vermin would be found there, and animals and humans from time to time come into contact with them, and these links in a chain could not be dismissed so lightly as Dr. Davies would have them dismissed.

Dr. WALFORD (Cardiff) had only a limited experience, but the two cases he had seen in Cardiff confirmed the experience of Dr. Davies—the infection probably being from rats, there being no evidence of any personal infection; neither had either of these cases transmitted the disease to any other human being. It was certainly true that they did not have a very prolonged opportunity of doing so, both dying after a short illness. His experience confirmed Dr. Williams' remarks that the destruction of rats on a ship was an extremely difficult operation. He had been successful with the Clayton apparatus, but he had also been pleased with the work of the professional ratcatchers. With regard to Dr. Hope's suggestions, he thought the Local Government Board might be asked to amend their Order of 1896.

Dr. HOWARD JONES (Newport, Mon.) said this question needed to be attacked firmly in this country as it had been in Australia. It was a question of the pre-

vention of the importation of rats, and at present it had not been firmly and fully tackled. The proportion of sulphur used in fumigation was generally insufficient; it was necessary to use it in considerable excess.

Dr. DAVIES, in reply, said he was glad to find that Dr. Ashburton Thompson had confirmed his opinion with regard to the conditions influencing the spread of plague amongst Western populations; he was also interested in Dr. Farrar's assurance that the Indians lived in a sanitary condition that compared favourably with that of the poorer class of English people. He had not intended to accuse them of living in insanitary conditions, because he knew nothing of Indian life, and only based his conclusions on the statements of others, and he readily accepted Dr. Farrar's correction. Dr. Thompson confirmed his opinion that insanitary conditions had only an indirect influence on plague. He believed the rat transmitted infection by way of the flea, and in dealing with the infected vessel in Bristol strict instructions were issued that the bodies of rats were to be taken up with tongs and plunged at once into a pail of strong carbolic acid and burnt in the ship's furnace; he also provided his men with strong indiarubber boots coming right up over the legs. With regard to Dr. Williams' remarks, he (Dr. Davies) thought it was possible to kill most of the rats on a ship by proper fumigation. No less than 226 were destroyed by two fumigations on the infected boat in Bristol. It was necessary to use a very large proportion of sulphur, and to fumigate every part of the vessel simultaneously, so as to prevent rats escaping by going from one part to the other. If the fumigation could be repeated, so much the better. Even if a few escaped, destruction of the majority greatly reduced the mathematical chance of infection, and, of course, a ship might not remain free; it would require refumigating at frequent intervals, and care should be exercised in loading and unloading, especially at infected ports. Possibly in the case quoted by Dr. Williams the proportion of sulphur used had not been sufficient; the SO_2 gas must be in excess. He accepted Dr. Hope's suggestion as to approaching the Local Government Board. He had not said that cases of human plague on board ship were to be neglected; but had said the regulations were sufficient to deal with these. Of course, they had to deal with human plague, but they could not afford to neglect rat plague, which was far more subtle, and far less easy to control.

It was resolved that the suggestions made by Dr. Hope be referred to the Council of the Society for consideration.

On the motion of the CHAIRMAN, a unanimous vote of thanks was accorded to Dr. Davies for his paper.

UNVACCINATED CHILDREN AND SCHOOL ATTENDANCE.—In consequence of the outbreak of small-pox at Bury St. Edmunds, an order has been issued against the attendance of unvaccinated children at school. The Education Department was appealed to on the subject, but replied that such children could only be excluded when the medical officer of health considered there was adequate cause; and this officer considering there was sufficient cause, the order was given. A similar instance recently occurred in the City of Westminster, with the result that two parents only objected to have their children vaccinated, while twenty other unvaccinated children were promptly protected.