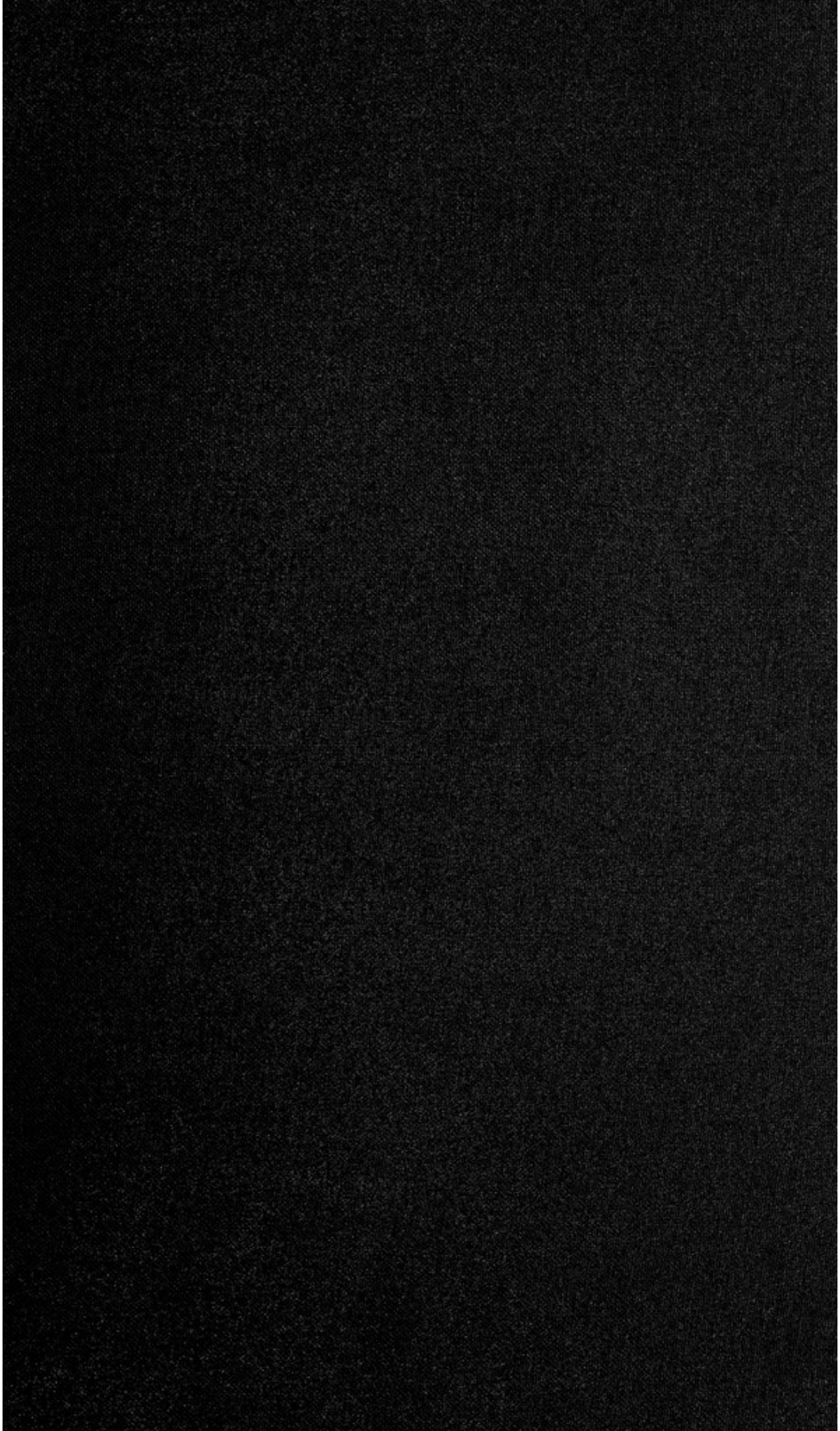
The aetiology of plague deduced from its epidemiology, as observed at Sydney during the years 1900-1904 / by J. Ashburton Thompson.



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NEW SOUTH WALES.

THE AETIOLOGY OF PLAGUE

DEDUCED FROM ITS EPIDEMIOLOGY,

AS OBSERVED AT SYDNEY DURING THE YEARS 1900-1904.

By J. ASHBURTON THOMPSON, M.D., D.P.H.,

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PREFACE.

The five reports which are bound together in this volume record the results of a systematic research, pursued at Sydney by epidemiological methods, into the aetiology of plague.

In the first paper the first case which occurred, and the bacteriological demonstration of its nature by the Microbiologist (Dr. Frank Tidswell, M.B., D.P.H.), are described. In the second, the question whether communication with the sick were the cause of the epidemic is examined; the result shows that this factor was inoperative, and carries with it the corollary that the disease spread by means which were external to man, and independent of his agency. In the third and fourth the efforts made to ascertain with exactitude the share taken by the plague-rat, and the incidental difficulties by which they were impeded, are set forth; while in the fifth something which nearly approaches to proof that the rat is the primary and essential cause of epidemic plague is given. Should it be thought worth while to study this investigation, the reader is recommended to begin with the fifth paper; it contains references to those which preceded it, and a general review of the five years' work.

In the third paper the necessity for a living intermediary between plague-rat and man, and the probability that it must be furnished by one or more species of fleas, are deduced from the epidemiological data, and are supported by a considerable body of circumstantial evidence not, at the time of writing, to be found elsewhere.

J.A.T.

Department of Public Health,
New South Wales, 14th October, 1905.

DEPARTMENT OF PUBLIC HEALTH, NEW SOUTH WALES.

The Secretary to the Board of Health to The Under Secretary for Finance and Trade.

Sir, Sydney, 1 June, 1900.

I have the honor, by direction, to forward an account of the epidemic of plague at Sydney, which has been prepared by the President for information of the Royal Commission on Plague in India, in accordance with the Minister's direction on the cablegram returned herewith.

I have the honor to be,
Sir,
Your obedient servant,
C. A. SIMMS,
Secretary.

AD INTERIM ACCOUNT OF THE EPIDEMIC OF PLAGUE AT SYDNEY.

Department of Public Health, New South Wales,
Sydney, 31 May, 1900.

For many years the trade of Sydney with Hongkong, Bombay, and Calcutta has been very great; consequently, ever since 1894 the attention of the staff of this Department has been anxiously turned to the risk run by Australia of acquiring plague by importation from these eastern ports. From time to time infection of other ports and places with which Sydney has direct and regular communication enhanced the risk, and maintained practical interest in it.

2. On 23rd December we became aware, through a press cablegram, that the presence of plague at Noumea had been officially announced. This town is the capital of New Caledonia; it lies only 1,050 miles away, and has regular communication with Sydney once or twice a month by mail steamer, as well as by steamships and sailing vessels with which a steady trade is carried on. At a later date reason appeared for suspecting that the disease had been present at Noumea much before December.

3. On 15th January the Government of South Australia notified the occurrence of a case of plague at Adelaide, and of two or three other cases somewhat later. The detailed reports of these occurrences hardly corresponded with plague under its clinical or under its epidemiological aspects, and lacked adequate bacteriological data; on the other hand, they contained statements which were unexpected and strange in this connection. It appeared, also, that the medical men more immediately concerned were not at one in their opinions of the nature of the illness or illnesses before them, whilst the general body of the profession at Adelaide do not think, and never have thought, that the disease written about was plague. I mention this matter merely in order to point out that the report, ultimately discredited though it was, yet served to maintain the attitude of alert attention which had been assumed by the profession at Sydney towards the end of December.

4. On 24th January, at Sydney, the case of A.P. was publicly declared to be one of plague. Nothing need be added to the official report upon it, dated 7th February, which is attached hereto.

5. On 24th February, the case of the deceased man D. was identified as one of plague at the laboratories of the Department. This was the second which came to notice. The patient had been ill a week, and had been attended by three medical men; there was a plain history of injury to the lower abdomen, received three or four days before he fell ill; but no peritonitis, or other usual consequence, could be made out. Nevertheless the illness, which was recognised as having the form of septic fever, was well marked, though apparently not immediately dangerous to life; and it was only after death had occurred unexpectedly that plague was judiciously suspected. Inguinal glands, which had become enlarged in the neighbourhood of the seat of injury were then immediately removed, and submitted for examination.

6. A third case was met with the day after D.'s. Cases and deaths occurred week by week as shown in the table below:—

NOTE.—Sydney alone was infected to the date of writing. The population of the metropolitan combined sanitary districts was 456,000, all being whites, except a small colony of Chinese, numbering less than 4,000. Cases and deaths occurred as shown in the table below. Included among them are 10 Chinese, all males, of whom 8 died.

1900.			
Week ending January 27	1 case	Recovered.
„ February 3	0	0
„ „ 10	0	0
„ „ 17	0	0
„ „ 24	2 cases	1 death
„ March 3	2 „	1 „
„ „ 10	5 „	3 deaths
„ „ 17	12 „	3 „
„ „ 24	10 „	3 „
„ „ 31	23 „	6 „
„ April 7	29 „	9 „
„ „ 14	29 „	12 „
„ „ 21	16 „	8 „
„ „ 28	26 „	7 „
„ May 5	38 „	10 „
„ „ 12	23 „	10 „
„ „ 19	24 „	10 „
„ „ 26	7 „	6 „

7. During the month which elapsed between attack of A.P. and of D., a good many cases attended by glandular swellings were referred to the Department for diagnosis, either by members of the profession or (occasionally) by the patients themselves. Almost always the glandular swelling could be traced easily to one or other of the usual causes. In none of them, nor in any of those in which the cause of swelling could not be precisely indicated, did the least reason appear for supposing that they might have been cases of plague in some mild or imperfect form. Very careful consideration of histories and of clinical symptoms, aided by exact and often prolonged bacteriological investigations, furnished no support to the notion which had made an accurate diagnosis desirable. A similar statement can be made concerning a rather long series of such cases which were presented in the course of the subsequent epidemic. Watchful attention has not revealed any reason for thinking that the latter has been accompanied by the minor and ambulant cases, which are said to have commonly occurred in the course of other epidemics elsewhere observed.

8. We are further unanimously of opinion—and here I express, I believe, the view taken by the profession in general as well as that of my staff—that the first recorded case was in reality the first case of plague which occurred at Sydney. While adverting to the contents of earlier paragraphs in support of this opinion, it may now be added (*a*) that examination of the mortality returns for the current year revealed no suspicious increase above the averages of former years; and (*b*) that the Registrar-General having forwarded, by request, all informations of death in which the cause was ascribed to blood-poisoning, septicæmia, pyæmia, septic intoxication, or acute abscess received by him on and after 1st January, suspicion of plague attached to none of them.

9. Turning now to the epidemiological aspect of this outbreak, it was observed, first of all, that the succession of cases could not be accounted for on any hypothesis which turned upon direct or indirect communication of the disease from person to person. Single cases in households were the common rule, and close contact with the patient during the first two or three days of illness (and sometimes more) betokened no special danger to the rest of the family. Successive patients were unconnected with each other by place of residence, and usually by acquaintance as well. It was also noticed that they were not connected in any of the more subtle ways which are sometimes difficult to demonstrate, and which are efficient causes of epidemics.

10. Nevertheless, it shortly appeared that successive cases were connected, though in none of the ways just mentioned. Speaking generally, it was observed of the early cases (being a series which constitutes about 20 per cent. of the whole number recorded to the date of writing) that as soon as locality in relation to habitation was exchanged for locality in relation to place of employment, nearly all were remarkably connected by resort during the day to the same part of the city. That part was the eastern side of Darling Harbour, the wharfs which there run in a continuous line of great length, and the streets immediately landward of them; and it appeared not to be dangerous in its whole length, but only in about half a mile of it, or a little more. This latter limitation was observable during earlier weeks at all events. The night population of the area thus indicated (which soon came to be known as "the infected area") was very small; the day population was large. I know at present of no means of estimating the latter, but it must amount to very many thousands. Several additional thousands of passengers by ferry-boat also crossed this area twice a day. These latter were not attacked.

11. But after all the proportion of those who were attacked to the number resorting to this area was small. It has already been shown that the infection was but little diffusible. It now appeared that the epidemic, although localised, could not be regarded as due to some cause acting generally within the area. Impartial consideration of the data, when they come to be furnished, will show, I believe, that some special circumstance, not commonly existent, was necessary to infection.

12. No search for this circumstance had to be made. Before the outbreak we were acquainted, of course, with the share in spreading plague which is sometimes ascribed to rats (Hankin*), and to the share intermediary between plague-rats and man, ascribed to insects (P. L. G. Simond†). It will be seen from the account of the case of A.P. that the remains of a small bleb, discovered on a protected part of the foot above which the femoral bubo appeared, had attracted attention; and from the advertisement immediately inserted in the daily papers requesting information concerning diseased and emigrating rats, that

Annales de l'Institut Pasteur, 1898, *p.* 703. †*Ibid.*, *p.* 625.

that it was thought the bleb had been caused by the bite of a flea, and that the inference that there must already be rats dead and dying of the plague in Sydney, had been drawn. This inference was justified by the event. On 10th February a landing-waiter drew the attention of the Collector of Customs to unusual mortality among the rats at the wharf (B) at which he was stationed; this information was conveyed to me in accordance with Departmental instructions given during January. Seven carcases were immediately secured, and were referred to the micro-biologist (Dr. Frank Tidswell). The macroscopic appearances presented by some of them were sufficiently well-marked to warrant a strong opinion that those animals had died of plague. It was thought necessary, however, to establish the fact by sure methods; and, in consequence of the putridity of these and of other carcases gathered from the same wharf, the evidence that they had plague became complete only on the same day that the glands taken from the deceased, D, were referred to the Department. Afterwards, it was reported by an inspector of fruit in the Department of Agriculture that he had noticed an unusual (though not excessively great) mortality among the rats which infested the wharf (A) at which he was usually employed, about January 14th.

13. Having ascertained that there was a connection between the persons successively attacked, and that it consisted in locality defined as place of occupation, not of residence; that the spread of the disease among persons resorting to that locality could not be accounted for on usual lines; and that plague-rats existed within it in great numbers; we considered it permissible to carry on the investigation on the supposition that (in our case at least) the infection was spread by rats. Thenceforward we assumed the general proposition that whosoever had plague had probably been in the close neighbourhood of plague-rats as a working hypothesis. At present we are of opinion that our further experience has supported this assumption.

14. Search for plague-rats in neighbourhoods and in dwellings where cases of plague had occurred was successful in a number of cases. Difficulty in obtaining specimens was often met with, and was often due to quite trivial circumstances. But this association between plague in man and presence of plague in rats was ascertained sufficiently often to cause long-continued investigation in relation to a sub-epidemic or local outbreak which had considerable interest, and in connection with which no plague-rats could be found at first. This happened at Manly, a village of about 3,000 inhabitants, separated by 13 miles of little-used road from Sydney, but easily reached by a 7-mile journey by ferry-boat. Several thousand people regularly resort there on every holiday or half-holiday, and a considerable proportion of the residents travel daily between it and Sydney. Six cases occurred there rather late in the epidemic, of which five were connected with one of the passenger wharves, while the sixth patient lived at a shop not far from it. Specimens of the local rats, both alive and dead, were at once procured; but poison had for long been laid for them, and no sign of plague was discovered in them for a time. It was not until the twentieth rat had been examined that the required evidence was furnished.

15. Community of rats at neighbouring wharves may be assumed. The first case of all, then, occurred in A.P., chiefly employed at a wharf near that (A, par. 12) at which unusual mortality among rats was earliest noticed, and not far from the wharf (B) at which such mortality was next noticed. The second case occurred in the man D, who occupied rooms a couple of hundred yards away from wharf B, and adjacent to another wharf; he had removed five dead rats from his water-closet at one time not more than three or four days before he was taken ill: the third in a wharf labourer daily employed at wharf B: the fourth in a publican who lived opposite to the same wharf in a public-house which was infested with rats, and so forth. And there were exceptions. Early distant cases occurred, for instance, in persons who had not visited the city within a reasonable incubation period, as follows:—One in a man employed by a produce-dealer who got his material (hay, straw, corn, potatoes) from wharf B; and five in a family which lived near a garbage-heap, to which refuse from all the infected wharves had been daily carted by the City Corporation before (and for some time after) their infection had become known, in whose cottage dead rats had occurred, and an extraordinary number of fleas. I believe we shall be able to show, with sufficient fulness, that at Sydney, wherever plague was contracted, there, as a rule, plague-rats were to be found.

16. It is generally considered that the cases reported to, and recorded by, this Department include all which have occurred. It would be straining probability to assert that none at all have been missed, but it is certain there has been no wilful concealment. The number of persons whose cases were thought doubtful which have been referred to my staff for diagnosis has been large. No doubt is entertained that on the whole the general statement that all cases which have occurred have come to light is justifiable.

17. Lastly, while expressing a hope that this summary statement of opinions and experience may be useful to the Commission on Plague in India, I would point out that as yet we have not had opportunity of completely arranging and digesting the mass of detail which has been accumulated. But those who have had experience in the management of serious, or at least of alarming, epidemics and in tracing their causes and course, are aware, doubtless, that this must be so at the present date; and that the clinical summary, the bacteriological and pathological account, as well as the results of experience in the use of Haffkine's prophylactic and of Yersin-Roux serum must also be deferred for the present.

J. ASHBURTON THOMPSON,
Chief Medical Officer of the Government,
President of the Board of Health.

1900.—New South Wales.

THE CASE OF A.P.

(REPORT OF THE BOARD OF HEALTH UPON.)

The Chief Medical Officer of the Government and President of the Board of Health to The Honorable the Premier and Colonial Treasurer.

Sir, Department of Public Health, Sydney, 7 February, 1900.

On January 20th Dr. Sinclair Gillies reported, with reference to plague, a case of illness encountered by him in the ordinary course of practice; he had had no clinical experience of the disease, but he had worked at its pathology two or three years before in the laboratory of the late Professor Kanthack at Cambridge. The patient was at once visited by the Principal Assistant Medical Officer of the Government (Dr. Frank Tidswell), and at later dates by myself.

I.—CLINICAL ACCOUNT.

A.P., aged 33, married, a rather slight but muscular man, fair, and of nervous temperament; had had no illness for several years past. On *January 19th* he was driving a lorry through the city about 12 o'clock, on a very hot day, when he was suddenly seized with giddiness, headache at the vertex, and pain in the region of the stomach; he was obliged to lie down for a time when he reached the warehouse to which he was then going, but afterwards finished his day's work, though still suffering. About four hours after attack he began to feel pain in the left thigh near the groin, and discovered a small lump which had not been there before. He left work at 6 o'clock and went to bed; he took some castor oil, and had free action of the bowels; he also vomited, the vomit being of natural appearance. He was very ill all night with headache, thirst, fever, and continued pain in the gastric region; the lump in the thigh ached continuously. *January 20th*, at 2·15 p.m., he was found dozing, but was easily roused to attention; his face was flushed, and a little puffy or heavy-looking; his eyes were slightly suffused; the skin felt burning hot, the axillary temperature was 104·9° F., and the pulse was rapid and bounding. Examination of the lungs discovered no sign of disease; he was able to move about the bed freely, and to show various parts of his body readily; he answered questions promptly and clearly; there was no delirium, nor anxiety, nor interference with speech; the spleen could not be felt. The left lower extremity showed the lowest gland of the femoral chain enlarged; it was just visible, was about the size of an unshelled almond, indurated, and but slightly tender on pressure; the swelling was well defined, and limited to the gland itself, there being no infiltration of the surrounding tissues; two other glands, which seemed not to be enlarged, could be distinguished just above it. There was no inguinal enlargement, and careful examination of the rest of the body failed to discover any other swollen ganglion, except one in the right submaxillary region; this was hard, was not tender, and, though the patient was unaware of it, was probably old. The genital organs were perfectly free from lesions of any kind, and there were no signs of venereal disease present or past. The leg was examined for injuries which might have given rise to swelling of the gland, but none were found. A further examination, made two days later, disclosed the following:—Behind the left external malleolus, and just anterior to the edge of the achilles tendon, was a circular spot, about 3 mm. in diameter; the cutis was purplish red; the cuticle which had been detached was then adherent to the skin; at one point of the circumference it was slightly ragged. It seemed probable that this had been a bleb; its circular form and protected position suggested that it had not been produced by abrasion; and, while the feet showed no evidence of chafing at any other point, the patient said he had been wearing the same boots for three or four months past, and that they had never hurt him. Three days afterwards the cutis had lost its reddish-purple colour, and new cuticle had been formed. Earlier observers felt unable to say that this lesion had not been present at the first examination.

On *January 21st* his temperature had fallen to 102·2° F.; the pulse was no longer bounding, and was occasionally intermittent (imperfect systole); he still had some headache at the vertex, but he had slept tolerably well, and was better. The gland formed a visible lump of the size of a walnut; the skin over it was slightly red, but it had been continuously fomented with hot boracic lotion; there was commencing peri-adenitic effusion, but no matting with the smaller glands immediately above could be made out. On *January 22nd* his temperature about midday had fallen to 99·2° F.; he was cheerful and alert, but pale and rather tremulous; the headache was less; he felt weak, but not exhausted; the gland had markedly increased in superficies, but was not much thickened, and though still quite tender was not at all acutely sensitive. He had slept well. On *January 23rd* the patient was in a similar state, but decidedly thinner and paler than at first; his temperature had risen again to 102·4° F.; the pulse was weak and easily compressed, but not intermittent. The femoral swelling had increased, and was nearly circular, about 2 inches in diameter. On *January 24th* his temperature was still 102·4° F., and his general state about the same; the femoral gland was of the size of a mandarin orange; it was still hard, surrounded with effusion, only moderately tender, and free from fluctuation (for further clinical account see Appendix A).

2.—BACTERIOLOGICAL INVESTIGATION.

The bacteriology of this case was described by Dr. Frank Tidswell in the following report:—

On January 21st a puncture of the gland was made with instruments just previously sterilised by exposure to steam for half an hour in the Koch steriliser. The cotton-wool wrappings were retained till the time of operation, and the instruments were still warm when used. The part had been continuously treated with boracic acid fomentations for the previous twenty-four hours. Just prior to the operation the skin was shaved, well washed with 5 per cent. carbolic lotion, then with recently boiled and still warm distilled water, and finally dried with sterilised cotton wool. Through the single opening in the skin by partial withdrawal the syringe needle was passed in six different directions through the gland. The piston was raised on each occasion, but no fluid entered the barrel of the syringe. On its final removal the channel of the needle was found to contain a minute quantity of blood. This was ejected over the surface of a serum culture tube brought for the purpose, and a second serum culture tube was inoculated from the first in the ordinary way by means of the platinum needle. Both of these tubes incubated at 37° C. remained sterile for a period of ten days, when their further observation was abandoned.

On January 22nd, whilst palpating the gland, a drop of pus-like fluid was expressed through the puncture hole of the previous day. On the 23rd and 24th also similar fluid was obtained in the same way. On each occasion the single drop issuing was used to make smear preparations, and cultivations on serum and agar; and that obtained on the 22nd was also used to inoculate a mouse. As the microscopical and cultural characters of the three samples of fluid were identical, one description will serve for all.

The fluid expressed was of a dark greyish colour, showing a little red (blood), but no yellow. A small portion set aside was found to have clotted firmly when examined half an hour afterwards. The amount of blood present was far too small to account for this clotting, and, moreover, the clot was pale in colour. It is evident, therefore, that the fluid contained a large admixture of lymph. Under the microscope the fluid was seen to contain numerous lymph cells. A few were normal in character, but most of them showed fragmented nuclei, and more or less granular cytoplasm, *i.e.*, resembled "pus cells." Lying in groups and singly amongst the cells were numerous bacilli, varying, but commonly ovoid or cylindrical in form, ranging between 1μ and 3μ in length and about ·5μ broad; ends tapering and finally rounded off; staining well with gentian violet, fuchsine, or methylene blue, and more densely at the poles than in the middle of the rods. The majority did not retain the stain when treated by Gram's method, although here and there an individual bacillus remained coloured. No spores were seen. Rounded bacterial elements were not uncommon, and the results of cultivation subsequently showed them to be micrococci, and not merely cocco bacilli.

The cultivations were upon ordinary serum and upon nutrient agar, the inoculations being made at the bedside with the platinum needle sterilised in the flame of a spirit-lamp. The tubes, inoculated about noon, showed definite growth on the second morning afterwards, *i.e.*, in about forty-five hours, having been incubated at 37° C. in the interval. The growths were of two kinds, one composed of micrococci, the other of bacilli.

The micrococcal growth upon serum developed in the form of rounded colonies, attaining a diameter of ·5 mm. in forty-eight hours, and extending to 2 or 3 mm. in three or four days. Thick, opaque, flat, slightly irregular margins, smooth surface, creamy white in colour. In subculture the growth was more rapid at first, a 1 mm. wide creamy streak developing in twenty-four hours. After this the growth extended slowly, reaching a width of about 3 mm. after five days at 37° C. No alteration in colour was observed. There was a thick deposit and turbidity in the condensation water. Upon nutrient agar the growth was similar to that on serum, but whiter. On glucose agar the growth was more abundant than on nutrient agar, and was well up in twenty-four hours. In bouillon there was uniform turbidity already apparent in twenty-four hours.

The cocci stained readily with gentian violet, fuchsine or methylene blue, and retained the colour when treated by Gram's method. Under the microscope they were seen to be regular in outline, and to lie singly or in groups (staphylo cocci). There were no chains. Individual cocci measured ·5 to ·8 μ. in diameter. The transverse line commonly seen in the pyogenic cocci was not detected in any of the specimens examined.

The bacilliary growth upon serum at 37° C. was scanty. It appeared in forty-eight hours in the form of small, round, slightly raised translucent colonies, of a little less than ·5 mm. in diameter. The growth had not extended much by the third day, after which, in the original tubes, it became overgrown by more rapidly developing micrococci. In subculture upon serum the growth was visible as a thin colourless streak, in forty-eight hours it increased to a band about a millimetre wide. After five days it formed a thin translucent streak still limited to the neighbourhood of the inoculation line, slightly thicker at the margins with outlying colonies, and showing granular raised specks at irregular intervals. Upon nutrient agar and glucose the growth was very similar, and when looked at from the back had a ground-glass appearance. In broth it formed abundant spicular or crumb-like particles attached to the side of the tube, with an obvious deposit of same character as that in Haffkine's prophylactic, the broth itself remaining perfectly clear and transparent. A filmy appearance on the surface disappeared on shaking, and was not reformed after four days at 37° C. In flasks with oil a film and a few pendent growths 2 to 6 mm. long were formed, as well as a copious deposit.

The bacillus stained readily with violet, fuchsine, or methylene blue. Is decolourised by Gram's method, although here and there individual bacilli or small groups of them retain the colour. Non-mobile, at least as regards obvious movements of translation. The bacillus shows very distinct bipolar staining, more marked in some specimens than in others, but clearly recognisable in all. This characteristic may amount to the colouration of only a polar granule, or to colouration of most of the bacillus, leaving only the middle of the rod unstained. Intermediate gradations are common. The bacillus varies very much in form, regularly cylindrical, boat-shaped, club-shaped, dumb-bell, and oval elements are the commonest forms. The length varies between 1 μ and 3 μ, and the breadth is usually about ·5 μ. The ends are rounded off. No spores were observed.

Some of the material obtained from the femoral swelling on 22nd January was inoculated at 4·30 p.m. into a mouse—into the back at the root of the tail. The animal was lively during all the next day. There was no visible swelling at the site of inoculation; but the mouse was not handled. Next day it was much less lively in the morning, and got very sick during the afternoon. At 6 p.m. it was huddled up, coat rough, respiration hurried, refusing food, but started up when the glass of its jar was flicked. It was found dead and stiff next morning at 9 a.m., having thus become definitely sick within forty-eight hours, and died within sixty-four hours after inoculation.

The principal *post-mortem* features were as follows: Hæmorrhagic œdema at site of inoculation; enlargement of the inguino-femoral glands on the right side; no enlargement of glands detected elsewhere; pericardium dusky, but no hæmorrhages seen; both ventricles of the heart distended with feebly clotted blood; lungs bright red in colour, patchy pneumonia (?); liver definitely but not very much swollen, mottled white and pink on surface; deep red on section; gall bladder empty, or nearly so; spleen not much, if at all, longer than normal, but thicker, swollen in such a way as to lose its normal sharp edges and assume a sausage-shaped form, section deep red, trabeculæ could not be seen with a hand lens; stomach normal, small intestine congested, large intestines not obviously affected, but contain fluid faeces; kidneys mottled, section pale, internal structure obscure; bladder distended with urine of normal colour. Smear preparations and cultures made from various organs gave the bacilli showing bipolar staining.

A second mouse, inoculated with a small piece of the spleen of mouse 1 on 25th January, at 10·30 p.m., was lively on the following day (26th). On the 27th it became sick, exhibiting the same symptoms as the first mouse. On the 28th, at 9 a.m., it was lying partly upon its left side—the hind quarters being in a normal position; but the forelegs were tucked away, the left shoulder touching the wire-gauge floor of the cage, and the head stretched out. It remained quiescent in this position till it died at 11 o'clock. The second mouse thus became sick in about forty-eight hours, and died in seventy-two and a half hours after inoculation.

The principal *post-mortem* features were as follows, the animal being examined ten minutes after death: Hæmorrhagic œdema at the site of inoculation; enlargement of hæmorrhagic infiltiation round the right inguino-femoral glands; enlargement of the left inguino-femoral, and right and left axillary glands, but no hæmorrhage. Pericardium dusky, but no hæmorrhages; right ventricle of heart contains fluid blood, left ventricle contracted and empty; lungs redder than normal, but not so much affected as in first mouse; liver slightly swollen, mottled pink and white on surface, section deep red; gall bladder distended with clear yellow bile; spleen not visibly altered internally, but section a little thicker than normal, and of a deep red colour; trebeculæ faintly discernible with lens; stomach normal, small intestines markedly congested, large intestine contains fluid faeces; kidneys normal on surface; section pale; structure obscure; bladder empty. Smear preparations and cultures were made from various organs gave bacilli as in first mouse.

A third mouse, inoculated on 28th instant with a small piece of the spleen of mouse No. 2, became sick on the 30th instant. During 31st January and 2nd February it had a series of seizures, characterised by very hurried and laboured breathing and prostration, and on each occasion appeared about to die. In the intervals it sat quietly huddled up, rarely moving, and taking very little food. It was found dead at 9 a.m. on the morning of 2nd February, having thus become sick on the second day, and died in about four and a half days. The *post-mortem* appearances were very similar to those shown by the other mice; in particular, the left inguino-femoral glands were swollen and surrounded by hæmorrhagic œdema, and the spleen enlarged to twice its normal size.

A guinea-pig, inoculated in left thigh on 25th January with a small piece of the spleen of mouse 1, showed no sign of illness till the 27th, but upon that day became quiet and drowsy, and took food sparingly. On the 28th it became very obviously sick, sitting huddled up with the back arched, eyes partly closed, and rarely moving. On the 29th and 30th it remained in very much the same condition, and was found dead at 9 a.m. on the 31st instant. The principal *post-mortem* features were as follow:—Hæmorrhagic infiltration at site of inoculation and in left inguino-femoral region; right groin normal; enlargement of and hæmorrhage round left axillary glands; right axillary glands enlarged; heart shows subpericardial hæmorrhages along auriculo-ventricular and interventricular grooves, and also along the edge of the right ventricle; lungs dark in colour, especially upper and middle right lobes, in which there is broncho-pneumonic consolidation; subpleural hæmorrhages in various places in all lobes; liver enlarged to about twice normal size, mottled red and white on surface, numerous small subcapsular hæmorrhages; spleen about three times larger than normal, deep violet in colour, showing very numerous white areas on both sides resembling miliary tubercle in appearance, edges rounded, no hæmorrhages; kidneys not enlarged, dusky in colour, hæmorrhages under capsule; suprarenals, especially left, enlarged and hæmorrhagic; bladder distended with clear urine giving albumin ring with nitric acid. No definitely abnormal appearances were detected in stomach or intestines. The blood-vessels found on reflecting the skin were markedly injected, and the blood fluid. The viscera were not sliced as it was desired to preserve the specimen with the organs *in situ*, for microscopical and cultivation purposes small pieces were obtained through areas on the under parts of the organs, previously seared in the usual way with a hot knife-blade. The smear preparations and cultures showed the bacilli already described.

A second guinea-pig, inoculated on 30th January with a small piece of the spleen of guinea-pig No. 1, became sick on 29th January, was very sick during 31st January and 2nd February, and died at 1·30 p.m. on 2nd February, having thus become sick in two days, and died in about four days. The *post-mortem* appearances were similar to those of guinea-pig No. 1, except that the spleen, though twice the normal size, did not show the miliary-tubercle-like appearance.

From the foregoing description of the bacteriological examination of material obtained from the enlarged femoral gland of A.P., it will be seen that two microbes were isolated—(*a*) a micrococcus still undetermined, but most likely one of the varieties of staphylococcus pyogenes albus; and (*b*) a bacillus answering positively to all the immediately applicable tests for *Bacillus Pestis Bubonicæ*.

FRANK TIDSWELL.

3.—EPIDEMIOLOGICAL RELATIONS.

A.P. was a lorry-driver, employed by the Central Wharf Company. His chief occupation was carting exports from city warehouses to the wharf, and delivering them either at his employer's warehouse or at the ship's side. For several months past he had been thus engaged in carting wool almost exclusively. Occasionally he used a truck to run goods from the warehouse across the wharf. He had not handled goods discharged from any ship since the previous August. He had no business on board ships, though he may occasionally have carried a message to the mates; and he had not been below on any ship for three months past at all events. Since Christmas he had only visited one other wharf, that of the A.U.S.N. Co., on January 9th, when he removed green hides imported from Queensland to a city warehouse. Both steam and sailing vessels from plague-infected ports must by this time (namely, near the end of the sixth year from the date of declaration of the epidemic at Hongkong) have discharged or loaded at every suitable wharf in the harbour; and, as regards Central Wharf alone, between November 1st and January 20th four steamships, which all carried Chinese crews, and which had all touched at Hongkong, had lain there—one of them from January 9th to 20th. (For the history of these four steam vessels see Appendix B; for the epidemiological relations of Sydney see Appendix C.)

4.—LOCAL CONDITIONS.

A.P. had lived in the house where he was found for eight years (see illustration). It was built of brick, on a sandstone ridge, which sloped rather steeply to a branch of the harbour, within the city limits, and in a neighbourhood containing many large warehouses. It had two stories, four rooms, a small attic, and an unused basement, of which the natural rock formed the floor. It was in average general repair, but the sewerage was seriously defective.* There were no inside fittings, but there was a yard gulley halfway down the small walled yard, and a water-closet at the end of it. These were drained by 6-inch glazed E.W.P., which ran forward under the house in a chase cut in the rock floor of the basement. The drain was in aërial connection with the sewer, and the last length of piping against the front wall of the house had had a considerable hole knocked in it; the interior of the dwelling was thus brought into direct connection with the interior of the sewer. On the other hand, however, the basement had a large opening at pavement level in its front wall, and a door at the back, both of which were said to be kept constantly open. The drain junctioned with a very old oviform rubble sewer, which discharged on the foreshore at Dalton's Wharf, about 50 feet below the house and about 150 yards away, next to the Central, and which was unprovided with any tide-flap. Very few houses were connected with it, and its chief use seemed to be discharge of storm-waters. In every domestic respect the house was tidy, clean, and well-kept.

5.—PREVENTIVE MEASURES.

The case occurred in a city much open to imported infection, and in a man whose occupation involved risk of encountering it if it were brought by sea, but in which, notwithstanding constant watchfulness, attention had not previously been attracted to illness suspected to be plague in any form. Under these circumstances, the clinical symptoms hardly sufficed to establish a well-defined suspicion of plague; most of the characteristic signs of the disease were absent. At first the fever corresponded with the slighter degrees of thermic fever met with during the summer in persons who labour in the sun, while swelling of a femoral gland in a man whose daily occupation exposed him to risk of such unnoticed injury as sometimes appears sufficient to cause it, required no special explanation. Yet the conjunction of sudden inflammation of the gland with the sudden access of fever held attention from the first. One thing, however,

* This is too generally the case within the city of Sydney, which in this respect is very sharply distinguished from the rest of the Metropolitan area. In the latter sewerage is under exclusive control of the Metropolitan Board of Water Supply and Sewerage; and the 38,000 houses, containing 182,000 persons, to which the Board's service had been extended down to December 31st, 1899, are in every case connected on the most approved principles.

however, was clear—that, at the worst, the chance of communication of infection to others from a case of the kind described was extremely small, and, under the sick-room management which was possible, probably non-existent; down to a certain date, therefore, it was thought unnecessary to take any other precautions than are customary when domestic isolation is attempted, and this judgment was amply justified by the event. Discovery of the remains of the bleb had some, though necessarily an uncertain, significance, for it was then empty. Discovery of a bacillus in matter expressed from the gland, and subsequently in culture therefrom, which resembled *b. pestis*, tended towards decision; but minute organisms are rarely identifiable on mere microscopic inspection, and other tests are requisite to reasonable certainty. It was not until the 24th, therefore, that it became clear that thenceforward the case must be treated as though it were one of plague at all events.

On the morning of the last-mentioned day the house and its inhabitants were placed in quarantine, under a police guard, and a special meeting of the Board of Health was summoned. Two or three hours later the patient was removed in an ambulance, under care of a wardsman, to the Quarantine Depot at Woolloomooloo Bay, and thence by a Quarantine tender to the Maritime Quarantine Station as soon as the members of his household had, at another journey, been brought to join him; they were six in number, and consisted of his wife, three children, a servant girl, and his sister. The next morning four contacts were secured and similarly transported, being all those persons who had visited the house since the beginning of illness. The premises being within the city, the Right Worshipful the Mayor (Sir Matthew Harris) was informed; he subsequently issued general notices to citizens, and took other steps.

As soon as this action had been taken the original reporter of the case, others who had been in contact with it, and the laboratory staff, were protected with Professor Haffkine's prophylactic; and this treatment was the next day extended to members of the ambulance, disinfecting, and quarantine staffs, as well as to the ten persons isolated, and the medical man (Dr. Murray Gibbes), who was placed in charge of the Quarantine Station.

Equipment of the Quarantine Depot was then directed by the Board. The ambulance, pair of horses, and driver employed on the previous day were retained, and four members of the Quarantine staff were directed to take up quarters there, two of them being disinfecters; had other cases followed a wardsman or a nurse, as might be necessary, would have been drawn from the Quarantine Station to accompany the patients during removal, and this course would have been continued as long as the accommodation (70 hospital beds; 350 beds in permanent buildings) sufficed for all who required isolation. But had cases begun to be met with in series, evacuation of the Coast Hospital (286 beds) would have had to be commenced, and its staff would then have become available.

The Board had decided on 29th December that plague should be added to the list of diseases notifiable under the Public Health Act, Part III; and a letter had been prepared recommending medical practitioners in the public interest to disregard the actual wording of the Act, which requires them to report such diseases only "forthwith on becoming aware that the patient is suffering from" one of them, and instead to report any case in which the symptoms and past history or occupation of the patient gave reasonable ground for suspicion of plague. It was now directed that an advertisement, addressed especially to owners of wharves and warehouses, masters of vessels, sewer-men, and scavengers, should be inserted in the newspapers requesting information concerning any unusual movement which might be observed among rats, and, should disease affect them, that some of their dead bodies might be forwarded for examination.

Disinfection of the house occupied by the patient was immediately commenced, under superintendence of the Medical Officer of Health for the Metropolitan Combined District (Dr. W. G. Armstrong). Usual methods were employed. Fumigation with burning sulphur was followed by saturation with sublimate solution, 1–1,000. Articles which could be boiled were so treated on the spot; other articles were removed in canvas bags for disinfection by steam. Wall-papers were washed off and, with all rubbish, were burnt on the premises. Eventually woodwork was painted, ceilings whitened, and new papers hung. Steps were taken to secure reconstruction of the sewerage. No rats were seen.

The contacts were released on the tenth day from their isolation. The patient's family awaited his recovery.

Down to the date of writing attention had not been drawn to any other suspected case, and no information concerning rats had come to hand. No symptoms of illness of any kind occurred among the persons detained, nor among members of the staff.

I desire to commend to your favourable notice the readiness with which all members of the staff took up their duty on this occasion, as well as the ability and skill with which Dr. Frank Tidswell performed his delicate task under circumstances of urgency which required almost continuous application to it during several days.

I have the honor to be,
Sir,
Your obedient servant,
J. ASHBURTON THOMPSON.

APPENDIX A

Further clinical account of the case.

Down to the date of writing the case called for no special remark, but pursued a steady course towards recovery. From January 26th (seventh day of illness) temperature, sleep, and appetite were practically normal. The gland continued to weep a serous rather than a purulent liquid by the needle puncture; the gland itself was first markedly diminished in size on the twelfth day of illness. On the same day the urine was found to be slightly albuminous; it had not been examined before, this point having been missed. Convalescence was not marked by any great weakness, nor by mental debility; for two or three days the patient had an obscure pain in the right calf which was very troublesome, though nothing to account for it was discovered, but with that exception the course of recovery was uninterrupted.

APPENDIX B.

APPENDIX B.

As to certain vessels referred to in the text, and progress of the epidemic at Hongkong.

The dates on which the four vessels had touched at Hongkong which, subsequently, during the same voyage, lay at Central Wharf, together with the duration of their stay there, are shown below:—

S.S "Prometheus."

Hongkong ...	... 11th Aug.,	1899.
Central Wharf	... 21–29 Oct.,	„

S.S. "Kaisow."

Hongkong ..	... 1st Oct.,	1899.
Central Wharf	... 18–23 Nov.,	„

S.S. "Ching Wo."

Hongkong ...	... 31st July,	1899.
Hongkong ...	... 8th Sept.	„
Hongkong ...	... 30th „	„
Central Wharf	... 31 Oct.–7 Nov.,	1899.

S.S. "Kintuck."

Hongkong	... 26th Oct.,	1899.
Central Wharf	... 9–20 Jan.,	1900.

The progress of the epidemic at Hongkong during months mentioned above, as noted in the British Medical Journal, was briefly as follows:—From the week ending 7th August to that ending 25th September fresh cases varied between 30 and 16, and the deaths varied between 30 and 16, each week; thereafter for weeks ending September 30th, 2 new cases, 2 deaths; October 7th, 2 cases, 2 deaths; October 14th, 0 cases, 0 death; October 21st, 1 case, 1 death; October, 28th, 1 case, 1 death; November 6th, 1 case, 1 death.

Amount and nature of lading received at Hongkong could not be ascertained.

APPENDIX C.

As to the epidemiological relations of Sydney, and progress of the epidemic at Noumea.

Dating from May, 1894, when plague was first recognised as epidemic in Hongkong, the number of vessels which have arrived at Sydney, and which have discharged or loaded there after having touched at plague-infected ports, has been great, and steadily increasing with the increasing number of infected centres. The communication has been by sailing vessels as well as by steam vessels in every case, and the duration of voyage has varied between about fifty days by sailing ship from Mauritius to from four to six days by steamer from New Caledonia. In several cases communication was regular by mail-steamer, and at least twice a month, besides by other classes of vessel; and trade with Sydney was especially great between Hongkong, Bombay, and Calcutta. The treatment accorded to all such vessels has been the same since the beginning, with exception of those lately arriving from New Caledonia, namely, that which for years has been accorded to clean vessels arriving from cholera or yellow fever ports. This has always been precisely that accorded by the Venice Convention, 1897, to ships arriving clean from plague-infected ports; for no vessel has arrived with any suspected case on board, nor after having had any such case on board during the voyage—at least as far as the fact could be ascertained by very careful inspection of all hands on arrival and detailed examination of the log. The exception made in the case of New Caledonia was necessitated by the nearness of that port, which is but 1,050 miles away; and the difference lay in detention of vessels arriving thence at Quarantine until expiration of twelve days from the date of sailing—a term two days in excess of that ordered by the Venice Convention, and imposed mainly because it was prescribed by the French Government in a code of instructions issued to Governors of its Colonies, &c., &c., during last year. Presence of plague in the capital, Noumea, became known through a Press message received on December 23rd.

Lastly, on January 15th, it was announced that two cases of plague had occurred at Adelaide. It is understood that the profession in that city are still awaiting tangible evidence that the illness was of that character; and communication between South Australia and other parts of the continent was not restricted by any Government.

Vessels which arrived from Noumea after December 21st were as follows:—

Name.	Left Noumea.	Arrived Sydney.	Wharf.
S.S. "Maroc"	18 December	21 December	Mort's Dock.
M.M. s.s. "Pacifique"	20 „	24 „	Circular Quay.
„	13 January	17 January	„
Ketch "Envy"	13 „	21 „	Johnstone's Bay.
S.S. "St. Pierre"	20 „	26 „	Mort's Dock.
S.S. "St. Louis"	26 „	1 February	At Quarantine.

For a day or two after arrival on each voyage the "Pacifique" first lay on the west side of Circular Quay, at a wharf which is only a hundred yards away from that at which the mailboats of the Eastern and Australian (Hongkong) line habitually lie.

The progress of the epidemic at Noumea is shown below:—

During the week ending	31st December	there were	12	cases and	7	deaths.
„	7th January	„	9	„	5	„
„	14th „	„	7	„	6	„
„	21st „	„	6	„	3	„

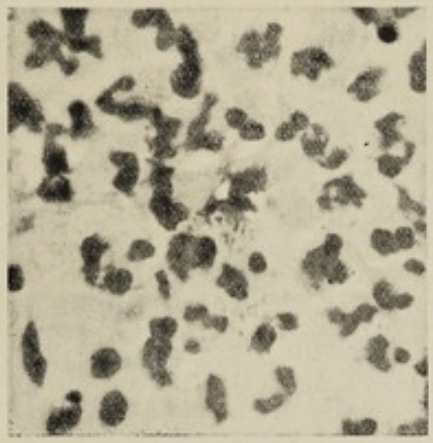

FIG. 1.—Bacilli in smear preparation of material obtained from enlarged femoral gland. x $\frac{1}{12}$ 800

FIG. 2.—Bacilli in coverglass preparation from culture. x $\frac{1}{12}$ 800

The house occupied by the patient is indicated by a cross on the pavement.

Sydney : William Applegate Gullick, Government Printer.—1900.

DEPARTMENT OF PUBLIC HEALTH,

NEW SOUTH WALES.

REPORT

ON THE

OUTBREAK OF PLAGUE AT SYDNEY, 1900,

BY

The Chief Medical Officer of the Government and President of the Board of Health.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1900.

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1900.

LEGISLATIVE ASSEMBLY.

NEW SOUTH WALES.

OUTBREAK OF PLAGUE AT SYDNEY, 1900.

(REPORT OF THE CHIEF MEDICAL OFFICER ON.)

Ordered by the Legislative Assembly to be printed, 4 December, 1900.

The Chief Medical Officer of the Government and President of the Board of Health to the Hon. The Premier and Colonial Treasurer.

Department of Public Health,

Sir, 13 November, 1900.

The recent epidemic consisted in the attack with plague of 303 persons between January 19th and August 9th, of whom 103 died; in addition to the suffering and the indirect losses which these figures denote, it necessitated a very considerable immediate expenditure and caused much damage to the commerce of this port. The object of the following account is to inquire into its origin and mode of spread, with a view to deducing the measures which are likely to be effectual in preventing a recurrence.

It will be seen at last that steady attention to the more commonplace details of municipal sanitation during absence of the disease alone affords a reasonable prospect of future safety. Simple as this conclusion appears it has the certainty which is attainable only through close consideration of the facts which, however, cannot be successfully observed save in the light of precedent investigations made in many branches of science. Thus it is unlikely that it will be easily accepted; yet not merely because the weight of the reasoning which leads up to it is hard to appreciate, but also because men still despise the humble stream, and vainly imagine the rivers of Damascus. There is no royal road to the prevention of plague.

It is hardly necessary to point out that the data described below were not accumulated without forethought and industry; this opportunity is therefore taken of commending to your favourable notice the zealous services rendered by the permanent and temporary members of the Staff, whose special duties are mentioned with their names. The Principal Assistant Medical Officer of the Government (Dr. Frank Tidswell, M.B., Syd., D.P.H., Camb.) remained in charge of the laboratories; his account of the observations and researches made by him will be found in Appendix A. The Medical Officer of Health for the Metropolitan Combined Districts (Dr. W. G. Armstrong, M.B., Syd., D.P.H., Camb.) took charge of the Visiting Medical Staff, which consisted of Dr. Theodore Barker, M.B., Ch.M., Edin., and Dr. Arthur Grieves, M.R.C.S., L.R.C.P., and of the Disinfecting and Ambulance Corps. The Maritime Quarantine Hospital was placed in charge of Dr. W. F. M. Shells, M.R.C.S., L.R.C.P., from February 24th to March 17th, and from the latter date to the end in that of Dr. A. E. Salter, M.B., Ch.M., Melb. Dr. Salter's analysis of the clinical records constitutes Appendix B. Mr. C. P. B. Clubbe, M.R.C.S., acted as Consulting Medical Officer, and visited the Hospital on alternate days; Dr. Gordon Macleod, M.B., Ch.M., Edin., Ophthalmic Surgeon (see Appendix C), was

 consulted

consulted on occasion. The ground external to the hospital enclosure was, on April 13th, placed in charge of Dr. Henry Harvey. The general management of the Quarantine Station was, as usual, in charge of the Superintendent of Quarantine (Mr. James Vincent), assisted by the permanent Quarantine Staff and a considerable temporary staff. The Nursing Staff was supplied from the Coast Hospital and from private sources, the whole being under superintendence of Head-nurse Ford, of the Coast Hospital; the Ambulance Staff was also detached from the same Institution. The Inoculation Branch was controlled at first by the Headquarters Staff, but subsequently by Dr. W. F. M. Shells; from time to time many other medical men shared in this work, in which they were assisted by medical students at the University, and occasionally by the laboratory assistants under Mr. Robert Grant. The *post mortem* examinations were made by the Government Pathologist (Dr. George Henry Taylor, L.R.C.P. & S., Edin.), and by the Pathologist to Sydney Hospital (Dr. Sydney Jamieson, M.B., Ch.M., Edin.), whose notes will be found in Appendix D. Sanitary inspections of municipalities and of buildings on infected areas were carried out by a temporarily engaged staff of instructed inspectors under direction of the Board's Sanitary Inspector (Mr. P. E. Getting). About March 25th this staff was increased to 28 and, under the same officer, was turned over to the Department of Public Works to share in the general scavenging operations about that time commenced. The rat-killing staff afloat was managed by the Collector of Customs (Mr. N. Lockyer), and was under supervision of a Superintendent of Fumigation (Captain G. Tait). Others also ultimately bore their share in the multifarious branches of work entailed by the epidemic, but the present object is to draw special attention to those who were immediately connected with the Department; this statement may, therefore, be concluded by mentioning the name of the Secretary (Mr. C. A. Simms), on whom devolved, among many other things, the arduous and responsible task of keeping up communications and daily records, and of attending to visitors, more especially during the hours from 4·30 p.m. to midnight for many weeks together. All of the officers mentioned worked with an intelligence, discretion, and disregard for their own convenience, which are deserving of high commendation and special acknowledgment. For my own part, I beg leave to express here my sense of the obligation under which their generous coöperation and invariable loyalty, in circumstances which were always trying and sometimes difficult, have laid me.

To the Consul-General for France (M. Georges Biard-d'Aunet) and to the Director of the Pasteur Institute at Sydney (Dr. Emile Rougier) warm thanks are owing for the friendly efforts made by these gentlemen to facilitate despatch from the Pasteur Institute of supplies of the anti-plague serum of MM. Yersin and Roux; as well as to the Consul for France (M. L. Vossion), who at a later date presented the Department with a further and welcome quantity brought from Noumea. Unfortunately, neither arrived until the epidemic had begun to show the signs which betoken the period of decline; nevertheless, the public were reassured at hearing that a specific method of treating the disease had become available.

It will be noticed, doubtless, that the advice given by the Department before the plague came (December 26th), while the epidemic was but threatening (January 24th), and at its commencement (February 24th, see Appendix H), practically coincides with the conclusions drawn from the facts of our recent experience. Had it been generally accepted, it would have been well; but it was then impossible to mention reasons fully, nor could many things for which the public themselves clamoured at much later dates have been done at that time. Now, however, reasons can be deduced from facts within our own knowledge. An effort has been made below to express them in the simplest terms (Sections V, VI, and VII), and so that they may be understood by educated readers with little trouble; but if in spite of this attempt they still wear a technical aspect, it must be remembered that after all Preventive Medicine is a branch of science.

I. The Nature of the Disease.

The number of cases which occurred between January 19th and August 9th was 303. The number available for the following clinical description, however, was 262; for in 39 cases death occurred either before notification, or else so soon afterwards that no clinical observation of importance could be made, while two others lay ill at a distance from Sydney and have been omitted from mention.

In very few cases the occurrence of declared symptoms was preceded by feelings of malaise and weariness, which lasted one or two days. This ill-marked and uncommon prodromal stage need not be further referred to, and the observed course of illness may be generally described under the following five heads:—

Onset.—This was a period of from one to about twelve hours, during which the patient passed, very often with alarming suddenness, from a state of apparent health to one of severe illness. It was usually ushered in by a rigor which varied in degree from a feeling of chilliness to a severe shivering fit, and which occasionally lasted for several hours. Acute headache accompanied, or immediately followed, the rigor; it was almost invariably referred to the frontal region, was sometimes felt at the vertex, and was never occipital; it was sometimes accompanied with vertigo. Pain in the back and lower abdomen was common. Vomiting almost constantly occurred; like the headache, it sometimes accompanied the rigor, sometimes followed it after an interval of a few hours, occasionally it was represented by a mere feeling of nausea, sometimes it was severe and long-continued; the contents of the stomach were first rejected, afterwards a greenish or bluish bile was thrown up. The face was usually flushed, and the eyes suffused; the pulse moderately quickened, of good volume, and of apparently increased tension. In all cases which fell under observation during this period there was fever, the temperature ranging between 100° and 102° F. The bowels were constipated, most commonly; diarrhœa occasionally occurred, and even at this early stage warranted a bad prognosis; it was generally accompanied with tympanites. Occasionally at this time, also, superficial lymphatic glands in one or other region—the femoral, inguinal, axillary, subpectoral, cervical, etc.—became spontaneously painful; the pain was described as aching or pricking, and was accompanied with slight swelling and a little tenderness. In five cases out of the whole number, unaccountable swelling and pain in a lymphatic gland were the first signs of illness.

Ingravesence.—This period included a part of the first and the whole of the second day of illness: speaking generally, the symptoms to be shown in individual cases became manifest, and gradually increased in intensity. Often, but by no means always, the patient was now unable to rise from bed. The face was most commonly flushed; the eyes, suffused and congested, were either closed or half-open; not very infrequently the complexion was pallid or livid, and the expression pinched; in a few severe cases it was sallow or yellowish, and a peculiar smell exhaled from the patient. The tongue, very frequently, carried a white coating; this was confined to the dorsum, the tip and edges being either bright red or clean, and it continued moist or, in the severer cases, began to dry. The skin was hot and dry; but when the circulation was extremely feeble, as it was in severe cases almost from the onset, it was bathed in a cold perspiration. The temperature ranged at this time from 101° to 105° F., and occasionally the highest temperature reached during the illness was attained about the end of the second day. The pulse was now much quickened; it continued full, but began to loose tension; in a few cases it had already become weak, very easily compressible, and even dicrotic. Except in very slight cases, appetite was entirely wanting; thirst continued. The bowels remained constipated as a rule. The patient's general expression could rarely be described as anxious, and most often was dazed: sometimes there was mental restlessness, however, and he would exercise his ingenuity to furnish commonplace explanations of his illness, or of the glandular swelling. At this stage affections of speech, and (when the patient was out of bed) of gait, were observed. That of speech varied between slight blurring and almost complete loss of power to pronounce words, while that of gait was manifested merely by staggering; both were clearly due to muscular incoördination, and consequently a stage of alcoholic intoxication was often simulated. Hebetude describes the mental state of the milder cases at this date; but

but in many of the severer kind this had passed into stupor, or even coma, before conclusion of the period. In others, and more commonly, delirium commenced: it was characterised by excitement which not infrequently was furious; the patient constantly struggled to leave his bed, and had to be restrained; he suffered from delusions. In all cases sleeplessness was a marked symptom. The superficial lymphatic gland which had first become painful rather rapidly increased in size, on the average equalling a hazelnut: it was distinct, elastic, and very tender.

State.—The illness having attained the degree of severity above indicated during the first forty-eight hours, became established. The period of maximum intensity was reached; it lasted over the third, fourth, and fifth days, and was sometimes prolonged into the sixth. The temperature now fell, usually ranging between 99° and 102°. The more moderate attacks being excepted, the patient exhibited a state of complete and intense prostration: decubitus was dorsal, the body slipped down in the bed; all excitement abated, and muttering delirium took its place; stupor and coma were likely to supervene. Sometimes diarrhœa set in, and if at all severe was a fatal sign; or external hæmorrhages of grave significance—hæmatemesis, melæna, hæmaturia, or purpura, occurred. The pulse became smaller, weaker, and more rapid, dicrotous, irregular, or running. The tongue continued coated as at first, but now became dry and brown. Albumen was often present in the urine, but always transiently and in small quantity. The bubo increased rapidly in size; the gland often equalled a walnut, while periadenitic effusion increased the swelling to large proportions, and spread over the adjacent glands which were usually very slightly enlarged; although the spontaneous pain which had at first been present in it was almost absent, it continued extremely sensitive; the patient, if not insensible, disposed his limbs so as to avoid pressure upon it, and often its situation could be inferred from the attitude in which he lay. The skin over it also became much reddened. More than half the total deaths occurred on the third, fourth, fifth, or sixth days; they were often due to failure of the heart.

TABLE, I.—Showing the day of illness on which death occurred in 103 fatal cases.

On Day of Illness.	No. of Deaths.	On Day of Illness.	No. of Deaths.	On Day of Illness.	No. of Deaths.
1st	4	8th	6	31st	1
2nd	5	9th	9	38th	1
3rd	12	11th	1	58th	1
4th	20	12th	2	98th	1
5th	11	13th	2	Unknown ...	1
6th	12	17th	2		
7th	11	30th	1		103

During this stage, cough, due to slight bronchitis, and attended by frothy expectoration, was liable to set in. In a moderate proportion of cases scattered patches of pneumonia were observed; the sputa became less aërated, and contained a little blood, which often stained them uniformly and rather brightly; this expectoration did not at all resemble that of ordinary pneumonia.

Decline.—During the sixth, seventh, or eighth days the disease began to decline in the majority of those cases which terminated favourably. The temperature fell as a rule suddenly, and to about normal; but sometimes it was gradually reduced. All the other symptoms showed a rapid amelioration, and immediately on the fall of temperature sleep returned. The face lost its congested appearance, the tongue began to clean, delirium became mild, intermittent, or was present only for a time after awaking. The bubo continued, and during this stage generally began to soften, if it were going to suppurate; but in a good many cases buboes remained stationary for from six to eight weeks, and yet suppurated at last. The pulse continued small, feeble, and easily compressible, and feelings of great weakness began to be experienced.

Convalescence.—About the ninth or tenth day the stage of convalescence was entered upon in the majority of cases. Almost all the symptoms hitherto mentioned entirely disappeared; only great cardiac weakness and the bubo remained. The temperature

temperature often became subnormal, usually about the ninth day; it sometimes fell below 97° F., and continued subnormal for from one to three days. Suppuration now proceeded rapidly in the bubo, and was usually accompanied by some slight rise of the evening temperature; the abscess was most commonly opened on the thirteenth day. In a less, but considerable proportion of favourable cases, the inflamed gland began to diminish in size, and gradually disappeared by resorption, but this process occupied several, or even many, weeks. The length of the period of convalescence was very irregular; usually it was established thoroughly by the third week, when debility and some discharge from the bubo alone remained. The wound, however, was rarely severe enough to prevent the patient from taking as much exercise as in other respects he was fit for, though occasionally extensive undermining of the skin long delayed his discharge.

If from the foregoing description of the average course of illness in uncomplicated cases, which terminated either in recovery or death, we turn to consideration of individual cases, it appears that the disease exhibited itself in every degree of severity—that is to say, from a slight attack of fever which necessitated confinement to bed for two or three days at most, accompanied by such swelling of a single gland as was a cause rather of discomfort than of pain, to an ill-defined attack of malaise on which death supervened after a few hours—or more often to an apparently moderate illness, which ended with unexpected death in about forty-eight hours from attack. Of the first degree, Case 1 (Appendix L, p. 77) was a good example, while the following are among those which represent the second and third. Case 240, m., *æt.* 45.—It was noticed that the patient's appetite fell off a day or two before attack, but this was not unusual with him, and he made no complaint; he attended to his clerical duties as usual during the morning of May 19th, but at midday was obliged to leave by a fit of colic; he died at 10 p.m. Case 255, m., *æt.* 55.—The patient rose at 6 a.m. and performed his duties as ostler in the usual way, and without having been heard to complain, until 8 a.m.; made a good breakfast, washed and dressed, and sat by the kitchen fire; at 9·30 a.m. he was found dead. Both of these men were intemperate; but this was not so with Case 242, m., *æt.* 17.—The patient rose at 8 o'clock, and complained of slight headache and nausea; he went out, and at 10 a.m. was spoken with by a policeman who afterwards reported that he made no complaint, and did not appear to be ill; at 2·45 p.m. his breathing became laboured, and at 9·45 p.m. he died. The two following patients died unexpectedly, though not so abruptly. Case 142, m., *æt.* 5.—During April 22nd became feverish and vomited several times; during the next thirty-six hours continued feverish, was sleepy or dull, and a tender swelling appeared in the right groin. He died quietly, but suddenly, at about the fifty-first hour of illness, without manifesting any other symptom. Case 84, m., *æt.* 3.—Woke at 3 a.m. on April 5th, feverish, thirsty, and with some slight muscular twitching. Vomiting set in, and continued till midday of April 6th. During the afternoon seemed much better, and played almost as usual. At 6 a.m. on April 7th muscular twitching again appeared; he was sleepy or indifferent, and feverish, and he died suddenly about the fifty-first hour of illness.

Post-mortem Appearances.—These were observed in twenty-four cases (Appendix D, p. 64), among which the five last referred to above were included. From this set of notes it appears that petechiæ of the skin were noted in ten cases; petechiæ of serous membranes, visceral and parietal, or of the mucous coat of the stomach and intestines, in nineteen. They were usually of the size of a pin's head or a little larger, but sometimes as large as a threepenny-piece; and hæmorrhages, or hæmoglobin staining, in the areolar tissue around internal organs were sometimes noticed, apart from enlarged lymphatic ganglions. The spleen was usually enlarged, rounded, softened, and dark in colour on section; it was noticed that the trabeculæ were obscured in six cases; and in only two was this organ reported to be firm and in other respects of normal appearance. Inflamed, swollen, and sometimes necrotic lymphatic glands were noted in twenty-one cases, while in three none were found. They were surrounded with extravasated blood in fourteen cases, and in a less number of the latter there was also œdema of the surrounding areolar tissues. Buboes (sixteen) were—femoral, eight; inguinal, four; axillary, one; and cervical, three. The heart, which often contained soft, pale-yellow gelatinous clots, showed paleness and softening of the myocardium in four cases. The liver was enlarged in fourteen cases, and was

fatty

fatty as well in thirteen; this appeared to be a recent change. In two, minute whitish points distributed throughout its substance betokened necrosis; in three cases it was cirrhosed from old standing disease. The cortex of the kidneys was swollen and pale in twelve cases, and occasionally was speckled with pin-point hæmorrhages. In Case 84 the former condition was ascertained to be due to catarrhal nephritis at an early stage. The lungs were the seat of old-standing disease in three instances, in five others they were congested, in three others engorged with blood, and in eight others there was a moderate œdema; in one case lobular pneumonia was noted.

Bacteriological Evidence.—Once the presence of plague in epidemic form has been recognised, a large majority of cases can be quite certainly diagnosed by clinical methods alone; and this is fortunate, because rigid bacteriological proof of the nature of this disease can seldom be had before the fifth day from beginning to seek it. Nevertheless, not merely at the beginning, but during the course of every epidemic, bacteriological proof is occasionally demanded. At the beginning it is essential, in view of the consequences which at present follow on the announcement that an indigenous case of plague has arisen among the inhabitants of a large city or an important seaport. So momentous an opinion should not be given but on absolute proof that the disease is plague, and the proof remains incomplete until it has been supported by a bacteriological demonstration. In the course of an epidemic it is also occasionally required in cases of doubt; for accuracy of diagnosis is a first condition of successful management. But in this case the same rigid proof is not necessary as in the former, and a microscopical examination of the juice of an enlarged gland, or (in few and fatal cases) of the blood, will furnish all the corroboration needed to establish a diagnosis already highly probable on clinical grounds.

Bacteriological demonstration of the nature of the disease already described, consisted briefly in detection in the juice of buboes, and in some other tissues, secretions, or excretions of the diseased body, of a micro-organism which had the following morphological, cultural, and pathological characteristics, and a definite reaction to certain stains. The organism was usually present in enormous numbers in smears made from enlarged glands, or from viscera. The individual elements were segregated, though not infrequently two were seen end to end, as though they had been produced by recent fission: they stained with aqueous solutions of fuchsin, methyl blue, and gentian violet, and did not retain the stain when treated by Gram's method. In stained preparations it presented a matured form, which was either that of a typical bacillus, or else it was whetstone or boat shaped; interspersed among these were rounded, oval, or dumb-bell shapes resembling micrococci or diplococci. The greatest mixture of forms was observed in smears from tissues, but there was always a preponderance of the "mature" forms. The bacillary form had an average measurement of 1·8μ, and a breadth of ·8μ; the latter showed little variation, the extreme measurements of length were 1·6μ and 2·4μ. The rounded forms had a diameter between ·5μ and 1·0μ. The poles of the bacillary form were often more deeply stained than the centre; in some preparations, practically every bacillus showed more or less deeply stained ends, and a central portion which remained clear and unstained, and which varied in width between a small space and the greater part of the body of the bacillus between the ends. In other preparations only a few elements showed this bi-polar staining, and occasionally it was not at all evident. Cultivation on dry or salted agar produced crops of "involution forms"; some elements became greatly enlarged, so as to measure 5 μ. or 6 μ. in length by 1 μ. in breadth, without losing the shape or staining properties just described; others became otherwise altered, and formed sausage, pear, spindle, circular, or oval shaped bodies, having no resemblance to the bacilli from which they were derived. On nutrient agar, inoculated from buboes or viscera and incubated at 37° C., the first noticeable growth appeared in the form of minute bright specks in from thirty-six to forty-eight hours. In a day or two these colonies become colourless hemispheres from ·5 to 1·0 mm. in diameter; some of them then enlarged slowly to a diameter of 2 to 3 mm., became flattened, and cloudy towards the centre. The maximum development was reached in two weeks. Individual colonies were hard to pick up, slipping about under the needle; fused colonies were often tenacious, and could be pulled out in strings. In sub-culture the growth appeared earlier than in the original, and developed as a confluent streak, raised and cloudy along the middle,

but

but with thin, colourless, iridescent borders, which were often corrugated. At room temperature on this medium the growth was seldom distinct in less than five or six days, and only reached its maximum development in about three weeks. In beef-broth the growth was usually visible on the second day of incubation, in the form of crumblike spicules attached to the sides, with more or less deposit at the bottom of the tube, the broth itself remaining clear and transparent; but in other cases a moderate uniform turbidity was produced. Growth in broth-flasks containing oil resulted in production of a film, scanty crops of stalactites, and a copious deposit. The stalactites present at any one time never exceeded six or eight, and became detached, and sank to the bottom on the least jar; that more were not found at one time was probably due to unsteadiness of the laboratory shelves. The growth in milk was less abundant than in broth, and the milk remained unchanged. Inoculation of guinea-pigs was usually followed by death in four or five days; the extremes were two to ten days, but six were rarely exceeded. The inoculations were made into the inner side of the knee. *Post-mortem* there was sometimes hæmorrhagic swelling at the site of inoculation, and this extended up the thigh; there was always swelling, and usually periadenitic effusion and hæmorrhage of the corresponding femoral glands, while sometimes the related inguinal, and less often the lumbar, glands showed similar changes. There were petechial hæmorrhages under the skin, the serous membranes, and in the viscera. The lungs were almost always more or less inflamed, the liver enlarged (sometimes to twice its normal size), and the latter usually exhibited a fine mottling caused by appearance of white points or by small hæmorrhages. The spleen was enlarged to two or three times the normal, marked with white spots on its surface, was dark in colour, and had thick or rounded edges. The kidneys were enlarged, pale, and, as a rule, full of small hæmorrhages; the suprarenals were usually congested, and of a deep red colour. Occasionally plague bacilli were limited to the seat of inoculation and the bubo; but usually they were present in all parts of the body, though they were not always recoverable from heart's blood. They were twice recovered from the urine, and were never found in the bile. A bacillus having precisely the same characteristics and the same pathogenicity was recovered from the organs by culture. For a full account of the bacteriological observations made during this epidemic, Appendix A, p. 50, from which the foregoing abstract has been made, should be consulted.

From the foregoing account of the usual course of illness, which has been compiled exclusively from the symptoms recorded of each of the 262 cases which could be clinically observed, from the brief abstract of the *post-mortem* appearances noted in the twenty-four cases which alone were examined in that way, and from the abstract account of the bacteriology of the disease given above, it will be seen clearly that the epidemic illness now under consideration was plague. On comparing it with the published accounts of plague as it appeared in other parts of the world, it will be seen that it might have been compiled from records made in China, in Portugal, in India, in Mongolia, in Mauritius, or, in short, from the records of plague outbreaks in any part of the world from which such records are forthcoming. Nevertheless, certain minor differences between the disease as seen here and as it has been seen in India and China, for instance, are distinguishable. But they are non-essential; they are differences in degree of severity or of fatality, and are doubtless due to the indirect influence of local conditions of life—of feeding, housing, cleanliness, and also of race. And of the three recognised forms under which plague exhibits itself—that is to say, the bubonic, the septicæmic, and the pneumonic, the bubonic form was almost exclusively encountered. The septicæmic form was observed only in 17 cases, of which 15 were fatal; primary plague pneumonia probably not once, although a single case was met with (in a Chinese) which possibly may have been an instance of it, the circumstances having prevented the fact from being ascertained. Bronchitis and secondary pneumonia were not uncommon, carbuncles were seen in two instances, and inflammatory and suppurative affections of the eye six times (Appendix C), but for an analysis of the whole series of cases reference must be made to Appendix B, p. 58.

II.—Progress of the Epidemic.

Sydney alone was infected, although several persons first fell ill after leaving for distant places—a matter which will be further mentioned (see p. 32). The total population of the metropolitan area, as defined for registration purposes, was estimated at 438,300 on December 31st, 1899; that of the metropolitan districts as combined for purposes of sanitary administration, was about 456,000. Cases were removed from all parts of the latter area. This population included the small sprinkling of coloured persons usually found at seaports, and a colony of Chinese which numbered less than 4,000 altogether; the latter, for the most part, lived in three separate neighbourhoods. Among the Chinese 10 cases occurred, and 293 among the whites; 226 of the whole number were notified by 87 legally qualified medical practitioners, the remainder (77) having in almost every case been first visited by a Staff Medical Officer.

Table II.—Showing the number of attacks and deaths recorded during each week.

Week Ending.	Cases.	Deaths.
20 January	1	0
27 January	0	0
3 February	0	0
10 February	0	0
17 February	0	0
1st.—24 February	2	1
2nd.— 3 March	2	1
3rd.—10 March	5	3
4th.—17 March	12	3
5th.—24 March	10	3
6th.—31 March	23	6
7th.— 7 April...	29	9
8th.—14 April...	29	12
9th.—21 April ..	16	8
10th.—28 April...	26	7
11th.— 5 May ...	38	10
12th.—12 May ...	23	10
13th.—19 May ...	24	10
14th.—26 May ...	7	6
15th.— 2 June ...	17	3
16th.— 9 June ...	4	3
17th.—16 June ...	10	3
18th.—23 June ...	6	0
19th.—30 June ...	12	3
20th.— 7 July ...	1	0
21st.—14 July ...	3	0
22nd.—21 July ...	2	0
23rd.—28 July ...	0	1
24th.— 4 August	0	0
25th.—11 August	1	0
26th.—18 August	0	1

The weekly notifications showed stages of increase, state, and decline in the epidemic. During the first three weeks only 9 cases occurred, and they were pretty evenly spaced out. During the fourth and fifth weeks, 22 were notified. In the sixth the epidemic became established, and so continued for seven weeks more; two-thirds (208) of the total cases happened during these eight weeks. The period of decline set in with the fourteenth and continued through the nineteenth week; it was marked by great irregularity in the number of cases notified, the series having been 7, 17, 4, 10, 6, and 12. The epidemic then ceased. The twentieth, twenty-first, and twenty-second weeks yielded but 1, 3, and 2 cases, while the last case of all was noted in the course of the twenty-fifth week.

Variation of Virulence.—It is important to remark that the infection had its full virulence from the beginning. The mortality was heavy from February 23rd, when Case 2 died; yet among those which immediately followed it were some which did not exceed Case 1 in severity. The only change observed in it was enfeeblement. This began about May 1st; it was recognised on comparing the state of patients

patients on admission to hospital after May 1st with the state on admission of those received at corresponding dates of illness before May 1st. Nevertheless, among the majority of cases which, as a whole, testified to this, some which appeared to betoken unimpaired virulence were met with to the very end (see Appendix E, Cases 289, 295, and 303). Another point requires notice in this connection. It is that whereas it had taken seven weeks to furnish the first 100 cases, and four weeks to furnish the second, thirteen weeks elapsed before the 303rd case had been recorded.

TABLE III.—Showing the number of attacks and deaths under Sexes and Age Groups.

Age Group.	—5		—10		—15		—20		—25		—35		—45		—55		—65		—75		Total.	
Sex.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Attacks	8	7	11	6	20	11	49	6	35	7	45	10	46	6	16	4	5	5	4	2	239	64
Deaths...	4	1	1	3	2	3	18	2	15	1	15	1	14	1	10	1	4	4	2	1	85	18

Sex Incidence.—The disease attacked nearly four times as many males (239) as females (64). The slight information available on this head does not indicate any special liability of males to attack in other countries, and probably this special incidence may be accounted for by the stress of the disease having fallen on business portions of the city, and on that part of the population which daily leaves home for some place of employment. This conjecture is supported by consideration of the incidence on the sexes in two infected areas which were distinct from that just referred to, and in which it was nearly equal: on one area, out of fifteen "indigenous" cases (that is to say, cases in which the infection was in all probability received on the spot where the patients lived), only 7 occurred in males, but 8 in females (Paddington); and in another group of nineteen, 10 males were attacked to 9 females (Redfern). Slighter testimony to the same effect may perhaps be drawn from Table III, which shows that the incidence on males and females below 10 and above 55 was much more nearly equal than at the intervening ages.

Age Incidence.—The observed incidence was on ages from 2 years to 74; but more than half the cases occurred in persons at ages between 15 and 35, while more than two-thirds occurred at ages between 15 and 45.

General Fatality.—The total number of cases having been 303, the deaths were 103; the gross fatality was thus just below 34 per cent. But 10 of the patients were Chinese, a race amongst whom the fatality of plague is usually from 80 per cent. upwards; and, in fact, 8 of the 10 died. If these be deducted, the fatality of the disease amongst the remainder, who were all whites, was 32·4 per cent.

Fatality at Age-groups under Sexes.—Table IV shows the percentage fatality of the disease at four age-groups in the two sexes; the smallness of the figures relating to females (see Table III) should be borne in mind.

TABLE IV.—Comparative statement of the fatality among Males and Females at four Age-groups.

Age-groups.	—15	—35	—55	—75
M.	18 per cent.	37 per cent.	39 per cent.	67 per cent.
F.	29 „	17 „	20 „	71 „

Fatality,

Fatality, at successive periods.—The fatality of the disease was not uniform throughout the whole series of cases. It was absolutely as shown in the following Table, to form which the 303 cases have been divided into three nearly equal parts :—

TABLE V.—Comparing the fatality of the disease among three arbitrary divisions of the whole series.

100 cases (20 January to 12 April)*	Fatality, 38 per cent.
100 cases (12 April to 8 May)*	Fatality, 35 per cent.
103 cases (8 May to 9 August)	Fatality, 30 per cent.

* The cases which occurred on these days have been divided.

But in this Table the Chinese are included who, for reasons already given are a disturbing element in the calculation, and should be separately dealt with. When they have been excepted, the statement concerning the remaining 293 cases among whites only, assumes the following form :—

TABLE VI.—Comparing the fatality of the disease among three arbitrary divisions of the cases which occurred among whites, the ten Chinese having been deducted as shown below.

	Less Chinese.	
	Cases.	Deaths.
100 cases (20 January to 12 April)*—Fatality, 37 per cent. ...	1	1
100 cases (12 April to 9 May)*—Fatality, 37 per cent. ...	5	4
93 cases (9 May to 9 August)—Fatality, 23 per cent. ...	4	3

* See note to Table V.

A few days after commencement of the term during which the latter 87 cases occurred, Yersin-Roux serum become available, and was thenceforward steadily employed ; but it must be added that, in opinion of the clinical Staff, the virulence of the disease had already begun to abate about the beginning of May. The evidence which can be adduced in support of this judgment is given in Appendices B and E.

Meteorology.—Appendix M consists of a chart on which are described curves constructed from the daily notifications, the rainfall, the daily mean temperature, and the daily mean tension of atmospheric vapour. The data were furnished by the Government Astronomer (Mr. H. C. Russell, C.M.G., F.R.S.)

Suspected Cases.—From January 25th, when the nature of the first case was made known, down to a date long after that last mentioned in Table II, a total of 221 cases of suspected plague were reported to the Department for diagnosis ; 115 of them were referred by 69 medical men, 106 (of which 32 were presented by the patients themselves) through other channels. Many of the latter offered no resemblance to plague in any form, of course; and many of the former were referred from motives of prudence rather than because doubt as to their nature was really felt. But among these were several cases of glandular swelling, with or without other symptoms of illness. In nearly all of these cases the glandular swelling, could be referred to one or other of the usual causes without difficulty ; but in two or three of them no such cause could be assigned. However, very careful consideration of the recent occupation, place of residence, and habits of these patients, of the history of the illness and of the swelling, and of the results of a minute and prolonged bacteriological investigation, quite failed to furnish support to the notion which had made an accurate diagnosis necessary.

Ambulant Cases.—The suspected cases came to notice in greater number during earlier weeks, and thereafter with gradually diminishing frequency. The probability that the first case recorded was the first case in fact is supported on grounds which are given in detail in Section VI ; and nothing has come to knowledge which would render it probable that either ambulant or pneumonic cases occurred before

before or during the earlier two-thirds of the time covered by the outbreak. But late in the latter third of that time a few ambulant cases were met with: Case 273, came to notice from the patient himself reporting the serious illness of his daughter, and then mentioning that he had had a somewhat similar attack shortly before; and Cases 299 and 300 (unconnected with each other) were detected after their admission to the Coast Hospital for treatment of the results of an illness (suppuration of inguinal glands) from which they had suffered three and six weeks earlier. So that while the question whether the first recorded case were really the first case which occurred can be answered in the affirmative with great confidence, the further question whether the total recorded cases include all which happened cannot be affirmed without reserve. The accidental discovery of the three just mentioned renders it likely that other such cases occurred in which medical advice never became necessary, or else was sought at a date when the true cause of illness was no longer distinguishable. All that can be said with regard to ambulant cases is that in the general opinion they occurred only at the end of the epidemic, and then were few in number.

Removal to Isolation.—It is convenient to mention here the time which elapsed between notification of cases and their removal to isolation at the Maritime Quarantine Station. The account stands as follows:—

TABLE VII.—Showing the time which elapsed between notification of 303 cases of plague and their removal to isolation.

Removed on the day of notification	154
Removed on the day after notification, to avoid transfer at night ...	99
Removed on the second day after notification, the patients having been too ill on discovery to bear the journey	3
Removed on the fourth day after notification (being the first case, detained at home for investigation)	1
Isolated at country places and not removed to Quarantine	2
First fell ill at Quarantine	7
Died before notification, or immediately after	37
Total	303

253 cases required removal and could be dealt with in the regular way. 154 of them were removed on the day on which they were discovered, while 99 were not removed until the next morning, merely because they had been notified so late in the day that otherwise their transfer must have been effected in darkness.

III.—PROTECTIVE INOCULATION.

Haffkine's prophylactic was alone used. As mentioned below, a small stock had been procured during the latter half of 1899; it was used for protection of those immediately associated with the earlier cases, including the members of the staff. No public inoculation was attempted until a further and large supply came to hand on March 12th. Two considerations governed the manner in which this consignment was expended: First of all persons who lived on, or necessarily frequented areas of known infectivity, had the best right to protection, and the most rational use of the supply was, clearly, inoculation of such persons; secondly, it was impossible (and quite unnecessary) to protect the whole population. But this intention was to a large extent frustrated. Between March 12th and April 2nd, when this supply became exhausted, about 8,000 inoculations were performed, including the small number done before March 12th, which was short of 300. There was then an interval, after which a fresh supply was received, and between May 11th and June 16th, about 2,700 more were done. On this occasion the arrangements made ensured inoculation of a larger proportion of persons considered to be in special danger of infection (see Appendix F., p. 71). Throughout the epidemic inoculation was offered to contacts, either on first being visited, or on arrival at the Maritime Quarantine Station, and the total number segregated having been 1,832, the number then inoculated was 180.

The total number known to have been thus protected was 10,700, all members of the various staffs included; no illness occurred among the latter, except Case 262 (see p. 37), a scavenger at the Quarantine Station who had escaped inoculation,

inoculation, but who was not the only one who was overlooked among the temporary hands employed from time to time. Among the inoculated public, 13 were attacked; particulars are given in the table below. All these patients not merely recovered, but had conspicuously light attacks. The cases occurred almost entirely among the earlier 200, while the virulence of the infection was at its highest, but also among the latter 93 (Chinese being excepted), when it had become feebler.

TABLE VIII.—Showing the dates on which thirteen persons were inoculated, and the dates on which they were subsequently attacked with plague.

No. of Case.	Date Inoculated.	Interval.	Date attacked by Plague.	No. of Case.	Date Inoculated.	Interval.	Date attacked by Plague.
	1900.		1900.		1900.		1900.
36	20 March.	4 days.	24 March.	57	23 March.	3 days.	26 March.
37	21 „	4 „	25 „	66	23 „	6 „	29 „
41	23 „	2 „	25 „	103	26 „	15 „	10 April.
42	23 „	1 „	24 „	115	13 „	1 „	14 March.
44	23 „	4 „	27 „	214	11 May.	0 „	11 May.
47	19 „	5 „	24 „	285	21 March.	93 „	22 June.
51	23 „	7 „	30 „				

There was one other and fatal case (164), which occurred in a boy who was attacked April 29th, and whose relatives insisted that he had been inoculated; they fixed the time, however, at about two months before attack, when none but those who had been in immediate contact with patients were being done. He was certainly not inoculated at that date, nor before commencement of public inoculation, on March 12th. His name could not be found in the register, which was carefully kept, of the names and ages of all persons inoculated by the staff, and inquiry among his fellow-clerks elicited only a vague statement from one of them, that he had been afraid of the plague, and had said something about a sore arm; this permitted the inference that he had been inoculated, but he had not made any direct statement on the subject. On the whole, the question remained undecided, although the statement made by his relatives is entitled to credence.

The immediate effects of inoculation were, in every case, it is believed, such as are commonly described. A few hours afterwards slight malaise and fever began, with swelling about the seat of the puncture; the feverishness increased, and the night was often restless; there was some slight headache and thirst; the temperature rose in observed cases (the night being excluded) from 2 to 3 degrees. The arm became painful, and after 24 hours there was usually a hard lump around the puncture (which was always made at the back of the upper arm), and rather extensive diffuse swelling below it, with much heat and redness. At the same time there was as much general malaise as might cause an unoccupied person to lie up, but not enough to interfere with important engagements. On or before the third day the malaise disappeared; the redness and diffuse swelling continued somewhat longer, and were attended with stiffness and slight tenderness; the hard central lump gradually diminished and could usually be still detected after from two to three weeks, though free from tenderness during the latter part of the term. The inoculations were always performed by medical men under antiseptic precautions; they were assisted by medical students and laboratory assistants. Not more than three or four cases of suppuration came to knowledge.

The inoculations done were hardly numerous enough to interfere with the natural course of the epidemic; but, in point of fact, no interference could be traced. Whole infected households had never been inoculated. If the person attacked had been inoculated it usually turned out that he alone had been done, often having submitted at instance of his employers; and in households where the patient had not been inoculated it was uncommon to find that even one other person among them had been done.

In accordance with the definition of the word "contacts," which will be found at beginning of Section VII, protective inoculation as a preventive measure to be used among a very large city population consisting of white people alone, and during an epidemic of plague which is under management of an efficient sanitary organisation acting under suitable laws, would appear to be practically restricted

to

to persons who cannot be removed from premises which are known to be infective; to those who, having evacuated the premises during cleansing, are returned to them while the area on which they stand is still infective; and to those who are obliged to frequent infective neighbourhoods, if they will receive it. It will be noticed that attacks which occurred at, or before the lapse of about ten days from, inoculation were not aggravated by it.

IV.—Serum-treatment.

Yersin-Roux serum became available on May 13th (Case 217). It was administered only by the Visiting Staff to cases diagnosed by them, and at the Maritime Quarantine Hospital. Its employment did not interfere with the natural course of the epidemic.

Although it was intended to give the serum regularly to all admitted to hospital without exception, so as to avoid selection of cases, it was found that this rule could not be adhered to without introducing an equally objectionable influence. The enfeeblement of the infection, which had begun to be observable by about May 1st, led many patients to defer seeking medical advice, and, consequently, to escape notification until comparatively late dates of illness, when they presented very slight symptoms of constitutional disturbance. Thus a dilemma was caused, out of which no way could be found: if the cases were not selected a false impression of the effects of serum-treatment would certainly be given; on the other hand, if they were selected on principles which necessarily could not be strictly defined, the value of the experience would remain doubtful to all but the observer himself.

Fortunately, averages and percentages are statements quite out of place in such connections as this. As a matter of fact, 22 of the 87 admitted after May 12th were not treated for one reason or other—in 9 cases, because the patients either died before discovery, or were then moribund. On the other hand, to the remaining 65 must be added 6 admitted before May 13th, and on that date lying in a nearly desperate state, of whom 4 afterwards died. Among the 71 were many very slight cases; but some account of all of them will be found in Appendix E, p. 70.

The opinion provisionally formed, and expressed subject to consideration of the day of illness on which the treatment began, the mode of administration, and the general features of each case, is that the serum has antitoxic powers which are manifested in useful recovery of the circulation from the depression which is a constant feature of the natural disease; but that in its present state it can hardly be relied upon as a very active curative agent. Probably the dosage requires revision.

V.—Administrative Measures.

Before the plague came the Board and its permanent staff had been watchful and active.

Appearance of the disease at Hongkong was the beginning of general interest in plague as a modern danger, and the beginning of the special interest of the Department in it as one thenceforward threatening Australia. On four occasions during 1894, and twice in 1895 (when it was thought the disease was dying out at Hongkong and the risk nearly past), as well as in 1896, when plague first appeared in India, this danger was discussed, and was made the subject of resolutions and of special directions by the Board. The steadily progressive spread of the disease in epidemic form to other parts of the world was seen soon afterwards to necessitate further precautionary measures, and additional preparations against it.

Possession and first-hand knowledge of the bacillus was clearly a primary condition of success in attempting to guard against the introduction of cases of plague, or to control spread of the disease after it had gained entrance. Accordingly, cultures of it were procured towards the end of 1897, and during the following twelve months its morphological and cultural characteristics were studied in the laboratories. In October, 1898, the Vienna incident became known; the popular impression it caused was obliquely communicated to the Department through official channels, and it was considered expedient to destroy the enfeebled and harmless specimens which then alone remained in the laboratories. At the same

same time, however, the Board caused a communication to be addressed to the Premier, in which it was pointed out that possession of cultures of the microbe was indispensable to due performance of its appointed functions. During the ensuing year, repeated representations to similar effect were made. But it was not until March 12th, 1900 (Case 14), that formal permission to keep, cultivate, and inoculate this microbe into animals was granted to the Board's micro-biologist by the Department of Lands, which administers the Animals' Infectious Diseases Act, 1888. In the meantime, however, verbal permission to keep, cultivate, and inoculate animals with the microbe of plague had been given by the Premier (March, 1899), and was again given by the Premier (December, 1899) to the President; for it was easy to show that if a suspected case of plague were imported, or occurred on shore, the Department would be in a dilemma in which it must either break the law by making cultures and inoculations, or fail in performance of its duty for want of power to use those means of investigation—means which were open to the rest of the world. It was considered that these permissions, although invalid in law, would suffice to protect the Department in a case where an absolute necessity could be shown. They were relied upon when in October, 1899, it became necessary to examine certain cases which had arrived at Newcastle by the British-India Company's S.S. "Ujina," from Calcutta, *viâ* Port Louis, Mauritius (which turned out not to be cases of plague), and again, in January, 1900, when the first case of plague occurred at Sydney. From this latter, indeed, the cultures in use at the laboratories during the epidemic were in part raised.

During the same term now referred to, namely, from September, 1896, plague had been frequently discussed by the Board in relation to maritime traffic, and had also been a subject of communication between the Board and central health authorities in other parts of Australasia. These communications commenced in January, 1897, and were thenceforward continued. At the end of that year the International Convention which had resulted from the Venice Plague Conference was referred to the Board by the Government; after prolonged consideration it felt obliged to advise that the Government should not adhere to it, the law containing no provision under which the plan of medical inspection permitted by the Convention could be carried out (see Section VII, p. 49). In March, 1898, Madagascar, Mauritius, Réunion, and the Seychelles were proclaimed to be places infected with plague, pre-existing proclamations having covered all other places with which New South Wales has communication, and which had so far been attacked. The gradual infection of a greater and greater number of widely-scattered ports and places was carefully noted, and its bearing on the interests of this port considered; and in October, 1899, the Government was advised to intimate its willingness to adhere to those parts of the Convention which provide for international notification of plague.

Even earlier than the last-mentioned date it had become apparent that, in all probability, Sydney would be attacked; and accordingly in January, 1899, the Board suggested that a member of the staff might be sent to Bombay to study the disease.

The danger which threatened was the importation of plague by sea, and no other. The treatment accorded from the beginning to vessels arriving clean from ports infected with plague (that is, from May, 1894, when plague became epidemic at Hongkong) down to December, 1899, was that accorded to such vessels by an earlier International Convention to clean vessels arriving from cholera-infected ports; a treatment which was also accorded by the Venice Convention to vessels arriving under the conditions now contemplated, that is, from plague-infected ports. But when it was announced that plague was epidemic at Noumea, a town which lies but from three and a-half to six days' steam from Sydney according to the class of vessel making the voyage, it became necessary to alter that method; and, while the regulations laid down in the International Convention were adhered to as far as possible, such vessels were compelled to lie at quarantine after arrival (whatever the state of health of those on board might appear to be) until expiration of the twelfth day from the day of sailing. This term was two days in excess of that prescribed by the International Convention, and was adopted merely because the French Colonial Office had issued instructions to Governors of French Colonies to impose it on vessels arriving at their Governments from plague-infected ports. But, in addition, attempts were made to kill any rats which might still remain on these vessels notwithstanding the efforts to the

the same end which had usually been made at the port of departure; and sometimes these measures yielded a considerable number of dead rats—in one case, as many as 283. Here it is well to note that the Venice Convention contains no reference whatever to rats, and the share they take in disseminating plague.

Lastly, as regards the measures of precaution and of preparation taken by the Board before the plague actually arrived, a supply of prophylactic was sent for about the middle of 1899; and when the infection of Noumea was announced, it turned out that prophylactic was available in this quarter of the world only at Sydney.

The presence of plague at Noumea in epidemic form was admitted towards the end of December, and the information became known in Sydney by cable on the 24th. On December 28th, 1899, the Board resolved that plague should be added to the list of diseases notifiable under the Public Heath Act, Part III., and it was proclaimed on February 6th. On February 1st, New Caledonia was declared infected with plague; and the Loyalty Islands, and the New Hebrides were declared likely to become so infected, by proclamation. The treatment already described was applied to vessels arriving from the latter groups. A cable message asking for a further supply of prophylactic was transmitted to Bombay.

It became known on December 30th that plague was epidemic at Honolulu, and it was announced that the same treatment would be accorded to vessels arriving thence as to those which came from New Caledonia, if they had communicated with the shore. It was also made publicly known by the Department that imported cases of plague would certainly be stopped at Quarantine, and that they were little dangerous; and it was pointed out that the first defence against the disease, under the circumstances then obtaining, consisted in killing all rats, the second in general scavenging of urban areas.

On January 15th, it was said that there were cases of plague at Adelaide, South Australia.

On January 25th, occurrence of the first case of plague at Sydney was made known. The Registrar-General was at once requested to refer to the Department every information received since beginning of the year, in which the cause of death was ascribed to blood-poisoning, septicæmia, acute abscess, septic intoxication, &c., &c., in order that further inquiry into such cases might be made if occasion appeared; and, since the notification of infectious diseases is by law required only as soon as the medical practitioner in attendance becomes aware that the patient is suffering from one of them, a circular letter was addressed to the medical profession on February 8th, in which a hope was expressed that the strict letter of the law would be exceeded, and that not merely cases of plague, but also cases reasonably suspected to be plague, would be reported by them to the Department (see Appendix N, p. 80); it was also desired that they might be reported direct—not, as the regulations made under the Act require, to local authorities in the first place. Circumstances attending the occurrence of this first case caused the Board to insert advertisements requesting information from owners and occupiers of wharves, stores and warehouses, masters of vessels, scavengers, and the public in general, as to unusual mortality or unusual movement among the rats at places under their control, and attempts were made in other ways to obtain such information. This case having occurred in the city, the President placed himself in communication with the Local Authority, and advised the Town Clerk on January 26th; it was then mentioned that some special scavenging and house-to-house visitation was already in progress. At the same time it was made known by the Department, through the public press, that there was little risk attending the care of plague-patients by the healthy, and the need to kill all rats was again insisted upon, as being the essential preventive measure then practicable. The patient was removed, together with his household and several contacts, to the Maritime Quarantine Station (see Diagram A); and in the report upon it, dated February 7th, it was pointed out, that if cases began to be met with in series, it would be necessary to evacuate the Coast Hospital. All members of the staff, and all who had been brought into contact with this case were inoculated with the prophylactic. The house was disinfected and painted; the contacts were released on the tenth day, the patient on the twenty-fourth day.

When the second case was discovered (February 24th), it was perceived that the fears which the circumstances alluded to above had caused the Department to express a month earlier were about to be realised. The same course was taken in isolating

isolating the family as before, but the Board now directed establishment of an ambulance service and of a disinfecting staff at the Quarantine Depôt, Woolloomooloo Bay (see Diagrams); and that temporary equipment of the Quarantine Hospital should be commenced, with a view to transmitting all patients and contacts thither until it should be possible to judge of probabilities in the near future. For it was evident to the Board that if a large number of cases should occur, not merely would the task of fully equipping this hospital for a purpose for which it was never intended, enormously increase the labours of the executive staff, but that it might easily happen that there would not be room enough in the enclosure for all the patients who must accumulate there, and for the nursing and serving staffs as well; while the need to transport all patients to it by sea from a point at the margin of the inhabited area would not merely entail very long journeys on many of them, but would also require organisation of land and water ambulance-services of considerable magnitude.

The infection of Sydney with plague was now officially announced. Once more the Department publicly stated that epidemics of plague were not kept going by communication of the disease from person to person, and again urged a crusade against rats; and it now suggested that a capitation fee should be paid for every dead rat delivered by all except the members of a special rat-catching staff, which should be at once appointed and paid regular wages.

On March 1st, a poster containing advice and instructions to householders was prepared, and subsequently exhibited very freely in conspicuous places all over the metropolitan area; and, notwithstanding the smallness of the Chinese colony, the apparent susceptibility of this race to the disease made it prudent to issue an edition printed in the Chinese language. At a later date (March 29th, case 48) this notice was reprinted in pamphlet form and posted to every householder in the metropolitan area (Appendix H, p. 75).

On March 2nd, the Department announced that for the future it would remove to isolation only actual sufferers from plague, and would quarantine houses and contacts only when the former were overcrowded and filthy, and presumably a source of infection. The plan was disapproved by the Government, which directed strict isolation of all people who had been in contact with plague-patients, and closure of the houses from which they had been removed. This decision subsequently appeared to be in accordance with popular feeling.

In the meantime, local authorities, both in Sydney and elsewhere, had begun to bestir themselves. As regards the City, it was mentioned that special inspection and scavenging had been begun as soon as the rumoured presence of plague at Adelaide became known, and that £2,000 had been thus spent down to February 26th. A house-to-house inspection of the city of Newcastle was carried out at the instance of the Medical Officer of Health for the Hunter River combined Sanitary Districts (Dr. Robert Dick); it had been begun about January 9th, and was reported complete about January 30th. Many metropolitan municipalities also announced the steps they were taking to put their districts in order. The Board gathered together a staff of instructed sanitary inspectors and caused them to visit all municipalities in the metropolitan district, and report (*a*) on the special measures alleged to have been taken or which were being taken; and then (*b*) on the effect produced, as judged after a perambulation of each district, and general inspection of dwellings. About March 2nd, it was stated that the local authority for the City had undertaken the systematic destruction of rats; and on the 9th, it was said, at a meeting of this authority, that 8,000 had already been destroyed. Doubtless, also, there was some private activity in this direction, the Sydney Meat Preserving Company having offered a reward to its workmen for every rat caught on their very extensive premises, as early as February 27th.

Fumigation of coastal vessels, with a view to destruction of rats, had been begun by the several companies at an early date; but a staff to carry out this work on all vessels loading at Sydney, trading between Sydney and other ports and places in New South Wales, or leaving Sydney for other parts of Australia or of the world, was organised and set to work by March 16th. It was placed under a temporary Superintendent of Fumigation, had its headquarters at the Custom House, and was generally supervised by the Collector of Customs (Mr. N. Lockyer). As regards vessels trading within New South Wales, it was ordered that, after leaving Sydney, they must not be allowed to communicate with the shore until they produced a certificate

certificate issued to them by the Department stating that the prescribed fumigation had been done while the holds were empty. These regulations worked without causing any serious interruption to traffic (see Appendix I, p. 76).

On March 22nd, regulations prescribing the mooring of vessels at wharves so as to impede the entry of rats to, and the landing of rats from them, were drawn up and recommended to the Attorney-General for gazettal (Appendix K, p. 77); this was done, but it was found that such regulations could be made only under the Wharfage and Tonnage Rates Act, 1880, so that they could be enforced only in the case of vessels mooring at public wharves.

On March 21st (Case 28), the President suggested to the Government that steps should be taken to call a Special Plague Committee into existence. Popular excitement had gradually increased until it had reached a pitch which threatened further serious interference with the Department's practical management of the epidemic. It was thought that such a Committee, if it included the leading members of the community, might steady the popular mind and afford the Department the kind of support in execution of its difficult and anxious duties which seemed about to become indispensable. Nothing resulted from the proposal at that time. But citizens presently began to move in the direction indicated; and on March 28th, the first meeting of a local Sanitary Committee was held in the municipality of Woollahra at instance, and at the house, of the Hon. Edward Pulsford, M.L.C., Mr. John Garland, M.L.A., in the chair. This example soon bore fruit, a similar Committee being called together at the Glebe, by Mr. J. A. Hogue, M.L.A., and a third at Paddington, on April 2nd. On April 11th, the Attorney-General (the Hon. B. R. Wise, Q.C., M.L.A.), attended a public meeting summoned by the Woollahra Committee, and, after explaining the Public Health Act and other sanitary enactments, took occasion to deliver some timely remarks on the indifference theretofore shown by the people in general to their civic duties, and on the tendency, which was universally evident, to rely on the Government not merely for administrative, but for executive, help in every kind of municipal work and responsibility.

The potential usefulness of such Committees was immediately perceived; and on April 11th, a general Committee, to be called the Citizens' Vigilance Committee, was instituted, which was to have a central office and sub-committees in every municipality. Alderman James Graham, M.D., M.L.A., became Chairman, and Messrs. John Garland, M.L.A., and J. J. Cohen, M.L.A., Hon. Secretaries. This Committee which, under its able managers, flourished greatly, and which still continues at work, did an incalculable amount of good in two main directions. In the first place, it laboured for and secured that coöperation of individual householders in the rat-killing business, without which it was plain the best efforts of the Government, and even of municipal councils, could yield but inadequate results; and, secondly, it set about systematically carrying out in every district the recommendation made by the Department on March 1st, in the poster and pamphlet then issued—namely, that every ratepayer should make it a rule to report to the local authority of his district every matter, or premises, which appeared to him to constitute a nuisance and a danger to health. Neglect to faithfully execute the sanitary powers entrusted to them had been a too common rule with many besides the City Council, though within the City its effects were exemplified on the greatest scale; and in the course of a few weeks the result of this scheme began to be evident, not merely in an improved public opinion, but in the changed attitude of all but one of the local authorities referred to. It seems likely that these results, which have flowed almost entirely from the public-spirited and wise exertions of the members and executive of the Citizens' Vigilance Committee, will in important measure prove to be permanent.

From the beginning, it had been gradually becoming clearer and clearer that the origin of the epidemic, as a local event, lay with certain wharves on Darling Harbour. (See Diagrams A, B, and C.) On February 15th (Case 1) and following days these places had been visited in detail by the Medical Officer of Health for the Metropolitan combined Sanitary Districts (Dr. W. G. Armstrong), and owners had been desired by him to take steps to cleanse them, and to destroy the rats about them. On March 11th, the President inspected them in company with the Collector of Customs (Mr. N. Lockyer), and ascertained that very little had been done in the desired direction; he thereupon communicated with occupiers, and threatened that

that unless large gangs of men were at once put on, and certain specified things done, he would quarantine these wharves. Already it had been perceived that if possible this portion of the city should be evacuated—the first object to be sought under such circumstances being removal of the inhabitants and daily visitors from the apparent focus of infection. But it was the headquarters of a very important branch of trade, and it was thought that this step could not be effectively taken without inflicting a blow on the prosperity of the country (for the welfare of every town would have been affected) which it was little likely to suffer from the epidemic—alarming as the situation was beginning to appear to the public who misconceived of plague as a highly infectious disease, liable at any moment to begin to spread like wildfire. And now two conditions became known, which made some further step than had hitherto been taken imperative. In the first place, while on the one hand it was soon ascertained that wharf-owners in general were not taking the measures which have just been referred to with anything like the requisite energy, it appeared on the other hand that their best efforts could hardly produce the desired results unless business were first stopped, because of the serious structural faults these old wharves exhibited. And then, secondly, the house-to-house inspection of this infected quarter, which was being carried out by the Board's staff of temporary sanitary inspectors, showed that it had fallen into a deplorable state from long-continued omission of the local authority to execute the ample powers to preserve the public health within its district which it enjoyed under its own Act of Incorporation, 1879, and under the Public Health Act, 1896. The result of this maladministration—now for the first time revealed to the general public, though well enough known in several quarters—was precisely that which sanitarians are aware must supervene in every large city, where, though there are good laws, there is an executive authority over a part of it which is at once uninstructed, indifferent, unguided by the routine of an efficient organisation, and ungoverned by strict principles of action.

As soon as these facts were apprehended the Government, after consideration, decided on March 23rd that the parts of the city and the line of wharves referred to, should be mapped out in convenient sub-divisions which should be consecutively closed, and given over to gangs of workmen under its own control. These gangs were to cleanse and disinfect streets, lanes, yards, and the houses inside and out; and, as regards the latter, note was to be made of all which had fallen into disrepair, or were so constructed that they should have been dealt with by the local authority under Part V. of the Public Health Act,with a view to making application for closing orders. The Board, therefore, increased its staff of temporary sanitary inspectors to twenty-eight, placed it under its sanitary inspector (Mr. P. E. Getting), and after furnishing it with a scheme of house-to-house inspection to be filled in and recorded, turned the whole over to the Department of Public Works. Successive portions of the city, which are indicated by dark shading on the three diagrams attached hereto, were closed to traffic and cleansed between March 23rd and July 17th.

Down to about March 23rd (Case 31), the Department had not succeeded—notwithstanding the increasing public alarm—in causing it to be perceived that it was beyond the bounds of possibility that it should not only advise and plan, but also actually supervise unaided all the varied proceedings which on such occasions become necessary. So far it had, by incessant and extraordinary exertions on the part of every member of its permanent and temporary staffs, not only succeeded in the tasks properly arising out of its acknowledged functions, but also in others which did not so arise and which had been silently imposed upon it. But when at this date it appeared to be tacitly assumed that it should supervise the collection, organisation, employment, direction and feeding of a scavenging staff which at the beginning was designed to consist of 1,000 men, and which soon came to number 3,000 men at work at one time, it became necessary to point out not only that this work ought to be intrusted to persons competent in it, but that other subdivisions must be shared out among other public departments which, down to this date (with exception of the Customs, and, as regards the quarantining of individual houses, the Police) had shown little comprehension of the mere physical necessities of the case. From that time forth each took its part. The various branches of the increasing business continued to be smoothly and efficiently worked. The Department was able to turn more attention to its proper occupations, which

from

from the beginning had been sufficient to engross the best energies of every member of the professional staff, weighted as they were with the thousand-and-one interruptions due to popular excitement.

The original supply of prophylactic had been reserved for use in the cases of those persons who had been closely exposed to infection, from their having occupied or frequented the same premises from which cases of plague had been removed; no general public inoculation had, so far, been possible. But on March 12th a fresh supply arrived. Systematic inoculation was begun in the building occupied by the Department. In the morning, ladies and a few other people who came in small numbers, were dealt with upstairs; that part of the general public which lived on, or was employed throughout the day in, the then infected area, was inoculated during the afternoon in the basement. On March 21st, however, the public, without any warning, suddenly arrived in very great numbers, and practically took possession of the building; they invaded the upper part of it, packing the staircases almost beyond possibility of movement, and at imminent risk of a disastrous accident. The building itself was, moreover, unapproachable through the large crowd outside it, which desperately resisted displacement from positions of advantage they had gained near the entrances. The next day, use of the Exhibition Building was granted by the City Council for inoculation purposes. Strenuous efforts were made to restrict public inoculation to those persons who either inhabited the infected area or were obliged to pass the day in it. The medical profession naturally desired that supplies of prophylactic should be placed at its disposal, but, of course, acquiesced in the necessity for restricting its application in the way just mentioned, as soon as it was pointed out; but a portion of the general public were determined to be inoculated at all hazards, though they stood in no known danger of contracting the disease, and very much of this first consignment consequently was wasted. When, at a later date still, a further supply had arrived and the method of inoculation had been organised (Appendix F, p. 71)—being done on this occasion in the basement of the city Town Hall—so entirely had all panic, or even lively interest, in the continued prevalence of the disease died out of the public mind, that between May 11th (Case 215) and June 16th (Case 278) only 2,700 persons presented themselves at the inoculation station, which, consequently, was then closed.

About March 28th it was suggested by the Government that if a new plague hospital were really necessary it should be put up somewhere between the Coast Hospital and Botany North Head, the minimum distance from Sydney thus indicated being 10 miles by road. On March 31st the Board reduced the term of detention of contacts from ten days, at which it had so far stood, to five days; and this was done because it was generally perceived that the former term was unnecessarily long. It was done at this time, however, in order to afford the Quarantine Ground a relief which the accumulation of contacts had made necessary. At the same date the Board once more recommended evacuation of the Coast Hospital; but after deliberation the Government decided that it would be dangerous to remove the patients then in occupation, and, besides, feared it might be necessary to destroy it afterwards if it were used to house plague cases. Not only was the contact camp at Quarantine overcrowded at this date, but the hospital itself was nearly full, being in considerable measure occupied by convalescents. On April 3rd, therefore, a part of the contact-ground and some buildings were transformed as well as possible into a convalescent hospital. This arrangement in turn trenched on the accommodation required for contacts, even after their numbers had been reduced by lessening the term of detention, to an extent which necessitated erection of some fresh buildings; and consequently the Board recommended on April 5th that such new buildings should be at once commenced. This was done. By this time the labour of equipping the hospital, which turned out to be greater even than had been foreseen, had been nearly completed, and as well as circumstances allowed; but only by the hearty and, indeed, self-sacrificing efforts of every member of the staff—medical, nursing, and lay. Quarantine hospitals afford little more than shelter; the buildings in this case happened to be more than usually extensive, but it is not expected—and practically it rarely happens—that more than half-a-dozen persons landed from an infected ship have to be provided for. Its equipment, consequently, and the staff quarters attached to it, little more than suffice to deal with some such small number of persons. There is a vast difference between such an establishment and a hospital which receives a constant stream of patients suffering from an acute fever, and liable

to

to all kinds of serious complications; and which, as a matter of fact, came to house for a long term more than 100 persons at a time. Accommodation for the nursing and serving staffs had to be improvised; they were moreover for months strictly confined to an enclosed area of, perhaps, a couple of acres to a large extent covered with buildings. The only relief which could be afforded the nursing staff was on their journeys to Sydney to attend to the removal of fresh cases, and a rare excursion on the water in one of the launches. It is due entirely to the energy and loyalty not merely of the staffs just mentioned, but of the Superintendent of Quarantine (Mr. James Vincent), and the permanent and temporary staffs under him, that the very great difficulties just adverted to were overcome; and the best evidence of their willing aid is the statement, which can be made without reserve, that whoever else may have suffered, at all events every patient was as comfortably lodged and as carefully tended as could have been the case in the best appointed permanent hospital. The conditions just indicated had been foreseen, and evacuation of the Coast Hospital was recommended in view of them; for by that plan an establishment completely equipped, in going order, and possessing its own ambulance service, would have been rendered available. As it was, the staff of the Coast Hospital had to be very freely drawn upon, in addition to private sources; 18 nurses under Head-nurse Ford were transferred from it to plague duty, whose places had to be hurriedly filled as they best might. Thus the Matron of that Hospital (Miss MacMaster) bore her share in the labours arising out of the epidemic, and succeeded in carrying on the institution very much as usual in spite of the loss of many of the leading members of the staff under her.

On April 17th arrangements were made by which the free distribution of disinfectants to local authorities, which had been going on since March 12th, was supplemented by the free distribution of rat-poison; the Premier also directed that every metropolitan local authority should be empowered to hire at least one man whose duty would be to distribute the poison, to instruct and stimulate householders in its use, to extricate poisoned rats from under floors and other situations in which they had died and become a nuisance, and to destroy the bodies of rats which he himself caught or received. Additionally, a deputation of Members of Parliament urged the Government, on April 11th, to offer a reward for the body of every dead rat delivered to appointed persons; and subsequently a capitation sum of 2d. was so paid. On April 27th, the capitation payment was increased to 6d., and with very satisfactory results as regards the number of rats brought in.

In addition to the measures already described several others were taken, to which but brief reference is necessary. Thus, the powers and duties of local authorities under the Public Health Act, 1896, were explained by the Honourable the Attorney-General, and on March 27th, a circular letter was issued from his Department to all those bodies; and when the deplorable state of some dwelling-houses, and the filthy state of parts of some neighbourhoods, became known in connection with inefficient administration of health laws by some local authorities, he directed that reports upon them should be referred directly to his officers, with a view to taking criminal proceedings against the responsible parties—owners or occupiers as the case might be—in a Court of Quarter Sessions. No such proceedings ever became necessary, but a great amount of cleansing and repairing was speedily effected as soon as they were threatened. So, also, a permanent hospital was erected at Newcastle, on the Stockton Quarantine Reserve, with the probable infection of that port (which is next in importance to Sydney itself) in view.

Local authorities in country districts were requested to secure refusal of a suitable cottage which might be got ready for use in case any person suffering from plague should be imported.

Attempts were made to impart to the public information concerning plague. Dr. Frank Tidswell, M.B. (Syd.), D.P.H. (Camb.), found time to prepare a paper describing the principal epidemiological, clinical, and pathological facts concerning the disease, which was read to a large meeting of the profession at the Royal Society's House on April 27th, and which was reprinted by the Government and suitably distributed. Professor T. P. Anderson Stuart, M.D., LL.D. (Edin.), delivered a popular lecture on plague on April 28th and on May 5th, which was subsequently printed by the Government, and widely distributed; and Dr. Camac Wilkinson, M.D., M.R.C.P. (Lond.), discoursed to the Ladies' Sanitary Association on the same subject on June 5th.

The policy of indiscriminate removal of both patients and contacts was adhered to till the end of the epidemic; patients were strictly isolated from contacts; contacts after bathing and changing to clean clothes were housed in common—that is, without reference to dates of exposure; inoculation was offered to them on arrival at quarantine, but was rarely accepted, and the term of their detention was five days, except quite at the beginning, when it was ten. Convalescents were discharged as soon as (*a*) they had had a normal temperature for ten days, (*b*) provided they had no unhealed sore, and (*c*) were in general respects fit for discharge. The three clergymen who resided at Quarantine and acted as chaplains (Rev. Father le Mesurier from March 22nd; the Rev. J. F. Moran from April 7th; the Rev. Alan McDougal from April 3rd), the medical staff, the consulting medical officer (Mr. C. P. B. Clubbe), and medical men who desired to study the disease, were allowed to enter and leave the hospital enclosure, the former to return to their quarters on the contact ground, the latter to the city, on condition that they had been inoculated, wore a special suit of clothes during the visit, and bathed before resuming their own clothes. The bodies of persons who had died of plague before removal were coffined by a specially engaged undertaker; the joints of the coffin were rendered watertight; the bodies were wrapped in a sheet wet with sublimate solution 1–1,000, the lid was screwed down, the coffin was then enveloped in a coarse cloth wet with sublimate solution, and delivered at the Quarantine Depôt. It was thence transferred to the Maritime Quarantine Station, and there buried without further precaution in sandy soil, on a steep slope falling to cliffs above the Pacific, and at a part of the grounds far removed from that in common use.

VI.—Origin and Mode of Spread.

All those conditions by which the natural course of the epidemic might have been interfered with or modified having now been mentioned, the epidemiology of the outbreak can be studied.

Five or six localities in different parts of the world are known to be endemic seats of plague; the disease has reappeared in them at short intervals during a long series of years, but it has remained confined to them. From one of these endemic seats, situated in the southern province of China called Yun Nan, plague was carried during 1893 along a caravan route to the town of Liao Tchou in the adjoining province of Kwang Si. From Liao Tchou it was transported by two routes. By one, which followed the Canton River, it reached the city of Canton, and became epidemic there in February, 1894; by the other it was carried to the seaport of Pakhoi, on the gulf of Tonquin. Either from Canton or from Pakhoi it reached Hongkong, where it was officially declared to be epidemic in May, 1894. It has been present at Hongkong ever since; in 1895 only forty-five cases were notified, but in 1896 it again became prevalent. During the latter year it reached India, and was officially declared to be epidemic at Bombay in September; subsequently it spread very widely thence, but Calcutta escaped until the Spring of 1898, or, probably, somewhat earlier. The best opinion is that the disease was carried from Hongkong to Bombay by sea.

Trade between Sydney and the ports of Hongkong and Calcutta has been great for many years past. As regards Hongkong two lines of steam vessels both make monthly voyages thither all the year round; the cargo steamers of some other lines sail between the two ports more or less regularly and frequently according to season; while there are in addition many irregular or casual vessels which arrive from China after touching at many places, including Hongkong. So that Sydney has been in danger of importing plague at all events ever since May, 1894; and the invasion of Calcutta, with which communication is frequent, greatly added to that risk. In Mauritius plague was first officially reported on February 27th, 1899, but cases had been observed as early as the previous December which subsequently came to be looked upon as plague; and this island has a steady though small trade with Sydney, which is carried on both by steam and sailing vessels. Kobe, Japan, became infected some time in December, 1899; Honolulu, H.I., on December 12th; and Noumea, the capital of New Caledonia, was officially declared to be infected on December 24th, 1899, when the news reached Sydney by cable. These are the infected places with

which

which Sydney has the most frequent and regular communication, and from which it was consequently most seriously threatened. Lastly it was announced on January 15th, 1900, that certain cases had occurred at Adelaide, South Australia, which were considered to be plague. The detailed accounts, when they came to hand, hardly pourtrayed plague under its clinical or its epidemiological aspects; they lacked adequate bacteriological data, and they contained statements which were unexpected and strange in connection with plague. The rumour, which from the first had been regarded with doubt, was ultimately discredited; and the matter is mentioned here only in order to direct attention to the effect it had in stimulating that professional alertness and public alarm which had already been aroused by news of the infection of Noumea.

Beyond pointing out the several ports from which plague might have been introduced into Sydney, and the great number of vessels which arrive from those ports during each year, nothing can be said as to the way in which the disease actually was introduced. Since 1894 no vessel has arrived which carried, or (as far as very careful examination and questioning on arrival revealed) which had carried, a case of plague in man. Theoretically the infection might be introduced in goods from infected ports; but the lengthy immunity from attack enjoyed by many cities into which goods drawn from infected centres have been daily poured during several years shows that in practice it is at worst very little likely to happen. All that can be said on this point, consequently, is that the first patient was a carman, who was regularly employed by the Central Wharf Co., who was chiefly occupied in carrying exports from city warehouses to Central Wharf [See Diagrams A, B, and C], and who occasionally visited other wharves to fetch packages in course of transhipment. It was ascertained from his employers' books that during 25 days before his attack (January 19th) he had had business at only one other wharf 10 days before attack, that of the Australasian United S. N. Co., Darling Harbour; but between October 21st, 1899, and January 20th, 1900, four vessels which had touched at Hongkong lay at Central Wharf—one of them from January 9th to January 20th. (For a full account of this case, see Appendix L, p. 77.)

TABLE IX.—Showing the Wharves on Darling Harbour only at which Steamships and Sailing Vessels, which arrived from Plague-infected Ports, lay between October 21st, 1899, and January 20th, 1900. (*See Diagrams.*)

Vessel.	From.	Lying at.....Wharf.	From.	To.
			1899.	1899.
"Prometheus" s.s.	Hongkong	Central Wharf ...	21 October ...	29 October.
"Rockton," s.s. ...	Noumea	Lime-street	28 „ ...	3 November.
"Ching Wo," s.s..	Hongkong	Central Wharf ...	31 „ ...	7 „
"St. Louis," s.s....	Noumea	Smith's	7 November...	11 „
"Kaisow," s.s. ...	Hongkong	Central Wharf ...	18 „ ...	23 „
"Rockton," s.s. ...	Noumea	Lime-street	24 „ ...	29 „
"Moana," s.s. ...	San Francisco and Honolulu	Union Company's, Margaret-street.	25 „ ...	20 December.
"Peru," barque ...	Mauritius	Grafton Wharf ...	27 „ ...	22 „
"St. Antoine," s.s.	Noumea	Smith's and Federal ...	5 December...	23 „
"Umballa," s.s. ...	Calcutta	Lime-street	15 „ ...	21 „
"Rockton," s.s. ...	Noumea	„	21 „ ...	29 „
			1900.	1900.
"Ione," barque ...	Mauritius	Grafton Wharf ...	6 January ...	17 January.
"Kintuck," s.s. ...	Hongkong	Central Wharf ...	9 „ ...	20 „

The case presented a feature, however, which was taken to show that in all probability the infection had been received neither from an earlier case of plague in man, nor from any infected article. The patient suffered from the disease in the bubonic

bubonic form, and the bubo appeared in the lowest gland of the vertical chain in the left thigh. In the external retromalleolar hollow of the same extremity was a circular spot, about 3 mm. in diameter; the cutis was purplish red; the cuticle which had been raised was then adherent to it, and at one point only of its circumference it was ragged. This observation (which I made on the third day of illness) suggested that the infection had been communicated by puncture at this spot, and that the inoculation was most likely to have been effected there—at a part of the foot which was well covered by the boot the patient wore—by an insect, namely, by a flea. The inference drawn was that rats were already dead or dying of plague in Sydney, and this formed the motive of the advertisement requesting information regarding disease among, or emigration of, rats which the Board caused to be inserted in the daily papers as soon as the nature of this case had been established, as well as of the prediction then uttered by the Department—namely, that although no cases would arise by communication from Case 1, yet other cases would probably be met with.

The full justification which this view subsequently received, supports an opinion that the disease was not introduced either by some unobserved imported case in man, or by importation of infected articles, but by infected rats; from which it spread to the local rats which, in turn, communicated it first to Case 1, and, as will subsequently appear, to other persons afterwards. But by what vessel, or from which infected port, such rats were landed at Sydney, there is no evidence. It may be pointed out, however, that communication with the remoter infected places had been extensive, and steadily maintained for long previously without introduction of the infection; and that the latter gained a footing only after the disease had appeared at Noumea, a port which lay close at hand. No official account of the epidemic in New Caledonia has yet been published; the following remarks must therefore be regarded as conjectural to some extent. The first case in man must have happened in New Caledonia some time before the presence of plague was acknowledged on December 24th; and it may have happened considerably before that date. But appearance of the disease among rats, not among the inhabitants, has most interest in relation to risk of importing the infection. Now, it was reported that the rats at Noumea suffered heavily during the epidemic; but the important question whether the epizoötic preceded the epidemic, cannot at present be positively answered, no authoritative information on this point having become available. A frequent experience, however, is that the rats suffer first, and usually several weeks before appearance of the first case in man. If this happened at Noumea there was nothing to prevent importation thence at any time prior to December 24th, for no special precautions were or could be taken at Sydney until after that date, when the disease was first officially admitted to be present there in man.

No information concerning mortality among rats was furnished in response to the advertisement mentioned above nor to other inquiries until February 14th, when an officer in the Customs Department drew attention through the Collector to unusually frequent deaths among them at Huddart, Parker, & Co.'s Wharf, on the eastern side of Darling Harbour (see Diagrams). The wharf being within the city, the President caused the local authority to be informed and advised, and in the course of the afternoon four live rats and three carcases were brought to the laboratories by the Chief Inspector of Nuisances for the city, who said it had taken him two hours to find them. At a later date an inspector of fruit in the Department of Mines and Agriculture reported that he had noticed an unusual mortality among the rats at Huddart, Parker, & Co.'s Wharf about the first week in January. Nothing further on this head has been discovered; and it is important to note that no suggestion that rats were suffering from an epizoötic at any other part of Sydney about or before the dates referred to has ever been made. The beginning of an epizoötic among rats occurred at wharves on the eastern side of Darling Harbour, and it first became manifest at Huddart, Parker, & Co.'s Wharf.

The seven rats above mentioned were at once utilised for the usual bacteriological and inoculation tests, and were shown conclusively to have been suffering from plague. At the same time, glands which had been removed from the body of a man who had died the previous day were brought to the laboratories, and on examination showed with sufficient certainty under the known circumstances that the cause of death had been plague. The beginnings of an epidemic are so important

that

that an account of Case 2, as well as of a few others of the earlier cases, is necessary. The patient had been attacked about February 17th. In the course of his brief illness he had been attended by three medical men, of whom two were called in consultation, not because of the apparent gravity of his case, but for reasons which can be inferred from what follows. A clear history of injury to the lower abdomen received three or four days before attack, and caused by a fall against a plank, was given. The disease was recognised as having the form of septic fever; but no peritonitis or other occasional consequence of such an injury could be made out and, in fact, there was none. The illness was well marked, though as it seemed, not immediately dangerous to life. Death occurred unexpectedly. It was then that plague was judiciously suspected, and that inguinal glands which had become enlarged and painful in the neighbourhood of the seat of injury were removed, and brought to the laboratories for examination at about 3·30 p.m. This patient, who died at his house in a suburb, was a sailmaker. His business is said to have been exclusively among locally-owned craft, and all connection with vessels coming foreign was denied for him by his survivors. He occupied a sail-loft on the water side of Sussex-street, not above 200 yards south of Huddart, Parker, & Co.'s Wharf, where he employed about forty workpeople, men and women. He had also a large household, part of which, at all events, had for some time lived at the workshop with him. As soon as the examination of the glands had been carried sufficiently far, the workshop was placed in quarantine at about 4·45 in the afternoon and, of course, without warning. On being questioned at that time as to the presence of rats there, the inmates said that deceased had removed five dead rats from a water-closet on the same floor two or three days before his attack. This closet was connected in a primitive fashion with a short pipe-drain which discharged under a wharf at the back of the house. No illness occurred either among the members of the family who had been as much associated with these premises as the deceased, nor among the many workpeople who were regularly employed there. No illness occurred, either, among the frequenters of the three premises above which the sail-loft ran, two of which were occupied by a produce salesman, and the other as a merchant's office; however, they were entirely cut off from the sail-loft, which had a separate entrance from the street.

Case 3 was notified by the medical man in attendance the next day (February 24th.) The patient lived on the western side of Darling Harbour, at Pyrmont, but he was a wharf labourer employed at Huddart, Parker, & Co.'s wharf. There was no history of dead rats at his dwelling, nor anywhere in the neighbourhood of it. This patient had a household of six persons, among whom no illness occurred.

Case 4 was notified on February 28th. The patient was a labourer in employment of a produce dealer who lived at the Glebe. He had not been anywhere near Darling Harbour for at least a fortnight before attack; but the supplies for the shop at which he worked all day were in large measure drawn either from Huddart, Parker, & Co.'s wharf, or from another close to it, at the back of the house occupied by Case 2, where the bales of hay, sacks of potatoes, &c., &c., often lay for several days before being delivered. In this case the disease could not be attributed to rats seen; and it may be suggested that the infection was conveyed adherent to some of the articles mentioned. The patient himself was too ill when first visited to speak as to presence or absence of rats, dead or alive, from the bales and sacks which he unpacked. No illness occurred either among his employer's family, or at the house (in a street a mile away) where he lived, and whence ten persons were transferred to observation.

Case 5, notified on March 2nd, occurred in a publican whose house was immediately opposite Huddart, Parker, & Co.'s wharf, and was overrun with rats. No case occurred among the other sixteen members of the household, who were removed to observation.

Case 6 occurred in a boy aged 8, who lived with his uncle and aunt and two other children in a house in Kippax-street, Belmore Park, and was notified on March 7th. No other case occurred in this street until eight weeks later (Case 180); it then seemed probable that the neighbourhood had become infected by extension from the focus to be mentioned in connection with the next case, though at the time of notification Case 6 could not be in any way connected with a probable source of infection. The house was not used for any business. The patient's uncle (who

(who was not attacked) was employed by a butcher whose shop lay not very far away, but in a neighbourhood which yielded no indigenous cases until long afterwards. It seemed that the child himself did not go far from home except to school. There had been rats on the premises, but they had been killed off about four months before by dogs obtained for the purpose, and there was no history of dead rats having been seen.

Case 7, which is the last which need be here mentioned in detail, occurred on March 8th, in a boy about 2 years old. His parents lived in a cottage which is indicated on the three diagrams by a cluster of five dots which represent the five cases which occurred in this family. The cottage stood in the neighbourhood of the City Corporation tip at Moore Park, a place where all the garbage and street-sweepings of the city are still dumped. To this spot refuse from the neighbourhood of the infected as well as other wharves was carried for some time after the fact of infection became known. There is no difficulty in showing clearly enough that the part of Sydney in this neighbourhood became subsequently a focus of infection which yielded many indigenous cases, of which the present was the first. The circumstances attending this case were the following:—The family consisted of the parents and six children. The cottage had had a good many rats about it; and in an outhouse in which the younger children used to play, one or two dead rats were discovered when, after attack of Case 7, it was cleaned out by the father. On these premises, also, the disinfecting staff found quite an extraordinary number of fleas; the bodies of the younger children were almost literally covered with their punctures. The only persons attacked were four young children who habitually played in the outhouse, and the father who cleaned it; they had none of them visited the garbage tip. All but the youngest child recovered.

The progress of the epidemic in point of time has already been described in Section II; its progress in place may be gathered from the diagrams lettered A, B, and C, which are appended. These diagrams have been constructed as follows:—In all three each case noted is represented by a dot; the dots are printed in four colours, each of which is appropriated to a period of time; thus black indicates the cases which occurred between January 20th and March 24th (Case 32); green, those which occurred between March 25th and April 21st (Case 129); red, those which occurred between April 22nd and May 19th (Case 239); and blue, those which occurred between May 20th and August 9th (Case 303), the end of the epidemic. On Diagram A the spots are so placed as to indicate the houses from which patients *were removed*, or, if they were actually removed from a general hospital, those they had occupied before admission to such hospital. On Diagram B they indicate the places at which the patients *were employed* during the time which covered the date of their infection; a working limit to latency—probably correct also—of five days being assumed, although of course the duration of employment at the place before attack had usually been lengthy. On Diagram C they indicate the probable *place of infection*, which was sometimes the residence, and sometimes the place of employment. The manner in which this place was fixed upon requires describing.

If Diagram A be examined, and if for the sake of clearness attention be confined to the black dots on it, which represent the places from which those cases which occurred between January 20th and March 24th were removed, it will be seen at once that the components of the series were not related by neighbourhood; for although one household afforded five cases, and although at another point six separate households appear close together, speaking generally the black spots are distant, and in several instances very distant, from each other. Secondly, it was ascertained that the members of these infected households were in all cases unacquainted with each other. Thirdly, the patients themselves were unacquainted with each other, except in certain instances in which they were associated at their place of employment or at home (Case 7). Hence it appeared that neither locality of habitation, nor personal communication, was the essential factor in infection. But the observed association of certain cases at their place of employment made it necessary to rearrange the diagram so as to show place of employment instead of the place of residence (see Diagram B); and this having been done, it appeared at once that the black spots were drawn much closer together, and were largely concentrated about Huddart, Parker & Co.'s wharf, and the eastern shore of Darling Harbour, although several of them still remained outlying.

It must be remembered that the time represented by the colour black was considerable (thirty days exclusive of Case 1) and that elucidation of the place of infection lay in reality with the circumstances surrounding the earlier cases of this period; and then, secondly, that the nature of our possible source of local infection had been established at an early date. It did not consist in an infection of the soil; no other reason in support of that supposition could be given than an assumed automatic commencement of specific infectivity of it, which, of course, is absurd. On the other hand it was already known to be present in the rats of the locality. Now rats are not confined in place, but can wander, and in accordance with their known habits were sure to occupy a wider area, or to migrate to different areas as time went on; and hence the black spots on Diagram B are concentrated about the original focus of infection only as regards the earlier numbers of the series, and even then with exception of Cases 4, 6, and 7. In fact, towards the end of the series indigenous cases began to appear at points rather far removed from the original focus (Case 20 at Rowe-street, City, 22 at Windmill-street, City, 23 at Walker-street, on the Redfern focus); and then, as time went on, cases began to be met with in which, although in some instances the patient was employed in or close to the original focus of infection, his case could not reasonably be referred to his place of employment on account of cessation of the neighbourhood it indicated to furnish a succession of fresh cases—because, in short, that focus had ceased to be dangerous. Also, other cases in persons who never had been near the original focus, and who had not been away from their place of residence, began to be met with in appreciable proportion (women and children especially), and with the neighbourhoods in which these occurred some of the cases just before referred to were associated. It became apparent, after careful study of all the circumstances, that fresh foci of infection had become established, and that it was no longer possible (as at first it had been) to assert *a priori* that wherever a patient might be found it would probably be ascertained on inquiry that he was in some way associated with the eastern side of Darling Harbour. The dissociation of these later cases both in place of residence and in personal communication continued to be as conspicuous as at first; if they lived in the same neighbourhood still their houses were more or less distant from each other, and although they might all possibly have encountered each other in the streets, by far the most often they were unacquainted. Consequently these neighbourhoods gradually became distinguishable, and entitled to be designated fresh foci; and as soon as this conclusion presented itself the same relation between them and the presence of diseased rats in them was observed, as had been first observed at the original focus. In many cases the evidence consisted merely in the reported observation of an unusual number of rats, and of dead rats, or of the death of rats in unusual places—under floors, in cupboards, or outhouses, &c.; but in some cases, elsewhere mentioned more particularly, it consisted in actual detection of plague in sick or dead rats, or (in one case) in a cat. Thus Diagram C, which represents the probable place of infection, was constructed from the whole of the facts concerning each case, after they had been weighed. It is in reality, therefore, an expression of opinion—very carefully formed, it is true, but not to be taken in all respects as a representation of ascertained fact; and that is the reason why Diagrams A and B (which state ascertained facts only) are presented along with Diagram C.

On Diagram C the black dots are shown almost entirely gathered together on the eastern side of Darling Harbour, and at the northern end of that shore. Cases 4 and 7 still occupy the positions originally assigned them—in other words have still to be regarded as indigenous to those places, or, at least, as having no personal connection with the original focus; and now Case 23 appears at Walker-street, Redfern, due west of the five dots indicating Case 7. It is the first in immediate relation to Case 7, and the garbage tip at Moore Park, and is seen to have belonged to a considerable collection of cases which occurred thereabouts at later dates. And thus, perhaps, a hint of a possible source of the infection received by Case 6 (Diagram A) is indicated; far as he lived from any area known at the date of his attack to be infected, he attended Bullanaming-street School, and to reach it crossed the area on which Case 23 occurred. To later extension from that area are also ascribed the cases to the north which are marked about the words "Surry Hills," east from Redfern terminus. These patients had no concern with Darling Harbour, nor even with any neighbouring part of the City.

To further illustrate the course taken by the infection in spreading to various neighbourhoods, it can be pointed out in relation to the black spot which indicates Case 4 that a green and two blue spots appear near it on Diagram C; not in very close contiguity to it, considering that the locality is closely covered with streets and houses, but still near it. These two colours respectively indicate the period which followed on that indicated by black, and the last period of all. A similar sequence of events might be described in relation to two or three other congeries of spots of different colours which appear on Diagram C. It might be suggested, therefore, that wherever one case of plague occurs there, or thereabouts, other cases may be expected. But the black spot attached to Case 4 indicates the place where the patient was employed; he did not lie ill there, and being attacked suddenly at midnight at his own house a mile away, which he did not leave thereafter except for isolation, he was not even on the premises while suffering, and therefore he could not have been the source of infection for the cases indicated by the green and blue spots, however indirectly. And, in fact, those cases belong to an extension of the infected area at the head of Darling Harbour.

From the head of Darling Harbour the infection spread to the neighbourhood of Redfern terminus, and thence in a south-westerly direction; a rat brought from the house indicated by a green dot towards the western end of Cleveland street and just above the words "Vine-street," as early as March 26th (Case 35) was ascertained to have died of plague. It did not cross the terminus, nor the railway lines to the south, nor the open spaces to the north of it. It proceeded from the terminus along George-street West, to be revealed in part by the cases referred to above as standing near the place at which Case 4 was employed; but it is possible, although, considering the lie of the country not so likely, that it reached this latter neighbourhood on a south-westerly course from the head of Darling Harbour; whence also at a much later date the indigenous cases shown on the promontory marked Pyrmont in all probability derived their infection. The green spots show that the above extensions occurred at all events before April 21st (Case 129).

Reverting now to the original focus, no less than 115 cases, or 38 per cent. of the total number are ascribed on diagram C to the area enclosed by Liverpool-street (running east from near the head of Darling Harbour), Elizabeth-street which intersects it, and a line drawn at right angles to a line produced from the northern end of that street in a northerly direction, so as to run westerly through the words "Bridge-street" and "Charlotte Place" to Darling Harbour again. Black spots (first period) are there seen only near the water; green spots (second period) are in a majority, and are present at the water's edge, but they also appear to the east of the black spot area; there are only two red spots (third period) close to the water, and to the east they far outnumber the green spots; there are but few blue spots (fourth and concluding period), and they chiefly appear at points far removed from any part of this area. As these four colours represent four divisions of the time over which the whole outbreak lasted, they indicate the direction in which the infection extended on this the most heavily stricken area of all, and indicate it very accurately. It appeared at the water's edge; it travelled easterly thence up the ridge which runs north and south parallel with Darling Harbour, and which culminates on the line of York-street; down the other side of this ridge to George-street; and up the ridge on the eastern side of George-street, as far as Elizabeth-street. There it was abruptly stayed; on the easterly side of Elizabeth-street, beginning at the intersection of Liverpool-street, are the uninhabited spaces marked on the diagrams. They are parks, or spaces on the margin of the parks occupied only with public buildings, and they stretch quite to the water at Bennelong Point, the northerly point of their westerly boundary being indicated by the line of Macquarie-street.

At a later date the infection did travel east of Elizabeth-street; perhaps closely round the southern end of the continuous open spaces just mentioned, but more probably from about Campbell and Hay streets (north of Redfern terminus). There was a distinct sub-centre of infection at that neighbourhood, to the south of Oxford-street, through which "Napier-street" runs; the building at the corner of Oxford and Dowling streets, marked by a red dot, being a brewery.

A quite separate focus which requires description became established at Manly. This place is a village situated on a neck of land at the northern end of the harbour, so that it has frontages both to the harbour and to the Pacific (see diagram A);

A); it contains about 3,000 inhabitants, many of whom travel daily to Sydney, and it is a favourite holiday resort which is visited by several thousand persons from Sydney every Saturday afternoon and Sunday. It can be reached by crossing from Circular Quay to Milson's Point, and following a road for thirteen miles, in the course of which the water must be crossed once more. This route is little used as a means of reaching Manly, although—a point of some importance—it is taken occasionally by waggons carrying heavy goods such, for instance, as furniture. The usual route is by ferry from Circular Quay; the distance being then seven miles, and the time occupied about half-an-hour. These ferry-boats convey considerable quantities of stores, including butcher's meat, every day. They lie at the wharves at either end between journeys and at night. From a misunderstanding, it happened that fumigation of these vessels to destroy rats on them, was not begun at the same time as on the ferries which plied from wharves on Darling Harbour.

The ferry runs to a single pier at Manly, on which are the usual shelter-sheds, and at the end nearest the shore a refreshment-room. The lessee had been allowed to convert a part of the structure into a dwelling, for which it was quite unsuited.

On May 1st, the case (163) of a man who kept a tobacconist's shop about 150 yards from the pier was notified. He had visited two warehouses in the immediate neighbourhood of the original focus five days before attack. This shop was subsequently demolished, and then many dead rats were found under the floor. On May 2nd the case (175) of a rouseabout at a public-house about six doors from the foregoing shop was notified. He slept in a shed at the rear of the hotel, getting his meals in return for his casual services, and hung about the pier when he was not wanted at the hotel. This person had not been away from Manly for many days before. On April 28th he removed several dead rats from the cellar of the hotel, on which premises no poison had been laid. On May 11th the case (213) of a vanman who lived in a street within a short distance of the pier, and who plied almost entirely at it, was notified; and the next day that of a girl (217) who was employed at the refreshment-room on the pier. This place was lined with matched-boarding and had a false floor; from this cover about thirty dead rats were removed during disinfection. On the 20th a boy who was practically unemployed, and who was always to be found at the pier if he were wanted to carry a message, was attacked with and died of plague (242). On May 29th the first of two cases in children (253), which occurred at livery stables just across the road from the pier, was notified; the house was emptied and disinfected May 30th, the family returned June 5th, and on June 25th the second case (288) occurred, the first being still in hospital; and between these two, on June 5th, the case of an ostler at another public-house opposite the pier was reported (257). The infected area was closed for general cleansing; and on July 12th, while this was still in progress, the case (298) of a man employed on the scavenging staff was notified. His place of residence was at Manly, but a mile and a quarter away from the neighbourhood of the pier.

Association of most of these cases with the pier is evident; but the first patient (163) had no other communication with it than consisted in frequently walking across it to the ferry-boat; while 175, 253 and 288, and 257 did not frequent it, although in the case of the two children it is likely they were often there. But 298 certainly had no particular communication with it, and, in fact, was infected only long after all the others (seventeen days), and only in the course of scavenging the area on which other cases had resided and (possibly, though not probably, with exception of 163) had been infected. Apparently, then, the infection, although communicated to persons who either frequented the pier or visited it casually more or less often, was not confined to it. On the other hand, it extended only to a short distance from it, and was markedly associated with presence of dead rats. Some of them, however, may have died of poison.

As soon as the first case was notified rats were sought at the pier and in its neighbourhood; nineteen were delivered at the laboratories, and all of them showed signs of disease. In eighteen of them, however, this could not be identified with plague (the bodies were very often more or less putrid), the signs consisting mainly in enlargement of the liver and spleen, and it seemed possible that these changes might have been the effect of poison (phosphorus for the most part), which had several weeks before been supplied to the local authority. Nevertheless, experience having

having already shown that where plague occurred in man there plague in rats existed and could usually be discovered, the tedious bacteriological search was continued until in the nineteenth rat (and in two others afterwards) plague was demonstrated.

This localised outbreak has many attractive features. Although in constant and unusually free communication with Sydney, the place escaped infection until the eleventh week of the epidemic. The occurrence of cases, and therefore the distribution of the infection, was limited to a very small area; an extremely small proportion of the persons living on and passing through that area was attacked, so that it seems that in addition to presence of infection some accidental, and not commonly existing condition was necessary to enable its communication to man. The pier seemed to be the gate by which the infection entered the place, and the special connection of several of the patients with it indicated that it was perhaps the centre of infection, or the most dangerous point of the small area. Lastly, so long as seventeen days after the last case occurred, and the area had therefore begun to be regarded as clean, it was discovered on sufficient search, namely in the course of scavenging operations, that infection still lurked in it. The discovery of plague-rats, and of a large number of dead rats at the pier refreshment-room and elsewhere, showed that plague infection was present on the area in rats, if nowhere else; and consideration of the points summarised above, together with the evidence which is later given that the disease was not communicated directly or (with a single exception) mediately from man, shows that a hypothesis on which the infection is assumed to have been introduced, and to have been spread, by rats comports so well with them that no other source of infection for man need be conjectured.

North Sydney is considered never to have become infected, although six households, shown only on Diagram A yielded cases. These, from which there was no extension of the disease were ascribed, with one exception, to infection received on the chief area in Sydney, where the patients were employed. The exception was the case of a baker's man, whose movements outside North Sydney could not be ascertained, and the source of whose infection was left undetermined.

The apparent spread of infection in Sydney itself need hardly be further traced. It will be seen from Diagram C that indigenous cases are set down far along the course of Oxford-street, the important thoroughfare which runs easterly from the city; along Parramatta-road, the main thoroughfare which runs westerly from the city; and along Botany-road, the main, but much less frequented, thoroughfare which runs southerly from the city. At some of these more distant places plague rats were identified or, as in one case, a plague-stricken cat (see diagram B); while at others there was often a history of dead rats, verified in 70 cases by the disinfecting staff. But it must be noted here that a spot map does not show details; and some of these distant cases are set down as indigenous with hesitation, in as far as the epithet implies—as, in its present use, it is intended to imply—local presence of the infection in rats, and therefore in an automatically transportable form. In a few of them it was clearly possible, as far as ordinary surrounding circumstances went, that the infection might have been introduced together with goods derived from the central infected area; but whether such goods carried deposited infection, or whether they merely harboured infected rats, dead or alive, is a question for the present reserved.

The general outcome of the foregoing examination of the manner in which the 303 cases of plague were situated and successively occurred on the whole area, is to suggest that the infection was in some way or other connected with place. Frequent references have been made to the ascertained presence of dead and of plague rats in this or that neighbourhood; but this has been almost unavoidable, and has not been intended to prejudice the case for other modes of infection, which are known to have operated elsewhere, and one of which, at all events, was seen in operation (in a single instance, Case 262, p. 37) at the Maritime Quarantine Station. And therefore the mode in which the disease actually did spread will now be examined from other points of view.

If the three diagrams be examined in general, it will be apparent on a little reflection that the conditions represented could be produced only by three causes, apart from infection of locality: These are infected water, infected food, and infected persons.

The

The two former can be certainly excluded without difficulty. The bacillus of plague can survive in water for short terms, which vary with the kind of water used (sterilised, distilled, main, or sea water); this knowledge, however, has been gained experimentally (except one observation on sea water), and it has not yet been noted whether plague can be communicated to animals from water carrying plague-bacilli. What is more to the purpose is that while the epidemic spread of plague by town water supplies has never been suggested, the accounts returned from several different parts of the world do not furnish the least ground for suspecting that it may have happened. As regards Sydney, it is enough to point out (*a*) that a very much larger area than that included in Diagram A is supplied from one primary source; (*b*) that while the water from this single source is pumped to, and distributed from, subsidiary reservoirs, more than one such reservoir must have been contaminated to account for the observed distribution of cases; and (*c*) that Manly has its own source of supply, entirely distinct from the former. Secondly, as regards distribution of the infection by food in any form, it is now generally admitted that the disease is rarely communicated to man by feeding; there is no reason for suspecting that this mode can have been a factor in any epidemic prevalence of the disease hitherto observed.

Remains, then, only habitual communication from person to person as a possible cause of the Sydney epidemic. This might be brought about directly or by mediate channels: the infection might pass directly from the sick to the well; or it might be communicated from the sick person to some place or object, whence the second patient could receive the disease without having seen, or even become aware of the existence of, the primary case. These are ways in which epidemics are known to be sometimes caused (of small-pox or scarlet fever, for instance). Whether they had any important share in contributing to cause the Sydney outbreak of plague is the question now to be examined. But, first, the difference there is between the possible communication of disease by one or other means realised only from time to time and rarely, and such a usual communication of it as alone can cause epidemic prevalences, must be referred to. All preventible disease should be prevented; and, therefore, if special dangers exist they should be guarded against by precautions specially taken against them. The first object, however, is to prevent epidemic prevalences; afterwards, the occasional causes of exceptional occurrences of the disease can be considered and steps taken to prevent even them.

In the first place, it may be inquired whether the facts furnish any reason for suspecting that infection mediately communicated from man was the cause, or an important contributory cause, of the epidemic.

How could such mediate infection operate effectively? Only by habitual diffusion of household goods. Only in this way could articles which had been in contact with, and which had received the infection from, the sick, be brought sufficiently often into contact with healthy persons; and such contact to have been a factor in the epidemic must have taken effect on persons outside the house occupied by the primary patient. Firstly, then, the infected households were much the most often those of respectable working-people who carried on no business at home, but who left home every day for some place of employment. These are not the people whose household belongings are commonly liable to wide diffusion; but if they were, the suddenness with which this disease usually attacks must be remembered, and that it would be singular if the first few days of an illness which was almost always alarming from the first, were chosen for such diffusion. Secondly, although in order to cause an epidemic spread of disease such communication must be between the primary household and others, yet, if it could take effect on the latter, much more should it take effect within the primary household itself; but it will be seen directly that only 10 altogether out of 276 households yielded secondary cases, and those occurred under circumstances so different that they cannot be classed together. If, then, mediate infection played so small a part (if any) within households, it could not have played a larger part outside them. One other possibility remains open, namely, unconscious diffusion of the infection by means of articles of commerce handled by the sick. Here, again, the suddenness of attack must be referred to. Persons did not, and, for the most part, could not, remain at work a moment after onset of the disease, and until then they

were

were incapable of communicating the infection. However, in the following table the occupations of the 303 patients are classified and presented :—

TABLE X.—Occupations of persons attacked.

Occupation.	Male.	Female.	Total.	
Food Trades :—				
Hotels and Public Houses	7	6	13	
Butchers	3	1	4	
Fishmongers	2	...	2	
Fruiterers	4	...	4	
Restaurants, Cooks, Waiters, &c.	6	3	9	
Bakers	2	...	2	
Provision Stores	14	...	14	
Produce Stores	14	2	15	
				64
Other Trades :—				
Carters and Horse Tenders	12	...	12	
Bootmakers	3	...	3	
Carpenters	6	...	6	
Ironworkers	5	...	5	
Painters and Plumbers	6	...	6	
Printers and Bookbinders	19	...	19	
Tailors, Drapers, and Shop Assistants ..	6	3	9	
Warehouses	16	...	16	
				76
Labouring Work :—				
Timber Yards	6	...	6	
Labourers (Miscellaneous)	19	...	19	
Wharf Labourers	11	...	11	
				36
House Work :—				
Domestic Duties (including servants and children at home)	26	45	71	
				71
Miscellaneous Occupations	32	2	34	
No Occupation	10	2	12	
Chinese	10	...	10	
				56
Total	.....	.....		303

Mediate infection as a cause of the epidemic may be excluded then, and without hesitation; the question of possible spread from man to man by intermediate animate objects being for the present reserved. The possibility that direct communication of the infection from the sick to the healthy was the cause of the epidemic spread of the disease now alone remains; it must be examined with care.

Two sets of facts furnish the requisite evidence. In the first place, those which concern the total cases will show whether the persons who did contract the disease got it from preceding cases; and secondly, the fate of those who were in contact (usually household contact) with the sick will show in what degree (if any) it was communicated to them.

The first statement is as follows:—There were 303 cases altogether; but thirteen were secondary cases which occurred in ten households; so 290 households yielded 303 cases. Four of the 303, however, occurred in members of scavenging gangs while

while they were at work on the area to be scavenged; these, though actually in contact with large numbers of people, cannot be reckoned as belonging to households. Four cases and four households must be deducted, therefore; and the statement then is, that 286 households yielded 299 cases (it is true, also, that several of the 299 had no fixed place of abode – but they had usually been in known contact subsequent to attack with more or fewer persons among whom no illness occurred, so that it is not worth while to complicate this statement by excepting them). But a further deduction must be made of ten Chinese who occupied ten different dwellings, because too little (and that untrustworthy) could be learned concerning them. So the nett statement, which applies to whites only, is that it took 276 households to furnish 289 cases. This by itself is sufficient to show that direct communication of the infection from the sick to the well could have occurred but rarely, and even exceptionally.

Among the cases just mentioned were some persons who, after receiving the infection at Sydney, travelled to more or less remote towns and there fell ill, from none of whom was there any extension of the disease. Particulars of these cases are given in the table below:—

TABLE XI.—Showing the number of persons who left Sydney and were attacked at distant places within five days thereafter.

No. of Case.	Residence in Sydney.	Left Sydney.	Arrived at.	On.	Distance from Sydney.	Was attacked.	No. of Contacts.
115	Balmain	April 13	Goulburn	April 13	134 m.	April 14	9
127	Balmain	„ 18	Menangle	„ 19	41 „	„ 20	1
154	Paddington	„ 23	Glenfield	„ 23	26 „	„ 25	5
166	Surry Hills	„ 28	Ballina	„ 30	331 „	„ 27	56
264	Pitt-street, City	May 30	Mittagong	May 30	77 „	May 26	4
...	Fireman, s.s. "South Australian"	April 3	Melbourne*	April 7	576 „	April 5	...
...	Fireman, s.s. "Gera"	May 5	Adelaide*	May 10	1,074 „	May 10	...

* Reported from these ports, where the vessels were held in Quarantine.

But it will already have been perceived that several other cases, which are precisely similar to those in Table XI, except in the comparative shortness of the distance to which they travelled from the centre, occurred within the metropolitan district (see Diagram A).

These particulars, which have been cited as evidence that the disease never within our experience was set going by the arrival at uninfected places of persons who fell ill shortly after, introduce the second set of witnesses which consists of those who lived for a time in contact with others who had the disease. Attention is here drawn to the statement already made that although inoculation was offered to contacts it was seldom accepted by them; to which it may now be added, that the total persons among the contacts (total 1,832) who were inoculated, either before being sent to isolation or on arrival there, was so small (180) that they may be left out of account in this connection. Further, it has already appeared from Table VII, that isolation followed very speedily on notification, and it may now be asked whether the contacts had remained in communication with the primary patient sufficiently long to contract the disease from him, if so it might be contracted. But the duration of exposure to the infection was the interval which elapsed not between notification

notification and removal, but between attack and notification; and what this was is shown for each of the 289 cases in the following table:—

TABLE XII.—Showing the day of illness on which 289 patients and households were removed to isolation. Also the number of secondary cases which occurred after isolation in four households.

Day of Illness.	No. of Cases.	No. of Contacts.	No. of Cases among Contacts attacked in Isolation.
1st day	10	156	.....
2nd „	35	170	.....
3rd „	77	458	1
4th „	53	320	5
5th „	31	240	.....
6th „	27	142	.....
7th „	14	66	.....
8th „	13	91	.....
9th „	7	40	1
10th „	5	24	.....
11th „	2	13	.....
12th „	1	2	.....
13th „	1	1	.....
14th „	1	5	.....
17th „	1	2	.....
20th „	1	1	.....
22nd „	1	.....	.....
46th „	1	.....	.....
Uncertain date	1	21	.....
	282	1,752	7

This table may be read in the following way:—458 persons were exposed to risk of infection from 77 cases during the first two to three days of illness, and one was attacked after separation from them and from the houses at which they lay ill; or, 240 persons were exposed to 31 patients during the first five to six days of illness, and none of them fell ill, &c., &c.

Plague as seen at Sydney during the outbreak under notice was not "catching."

Under certain circumstances, however, plague can be communicated from the sick to the healthy; and although Table XII shows only 7 secondary cases (because seven only occurred after separation from the primary patient and from the infected premises), the fact is that 10 households altogether yielded 13 secondary cases. The circumstances under which plague is known to be communicable from the sick consist either in the form assumed by the disease, or in inoculation of diseased products of the sick body. Thus, primary plague pneumonia is very easily communicated to others (but compare the statement contained in Dr. Lorans' report on the epidemic in Mauritius, p. 17), while several of the secretions, excretions, and tissues of the diseased body carry the bacillus which is the cause of the disease. Inoculation of these products can be effected in two ways: a wound may have been made first, and the diseased matter may have been subsequently brought into contact with it; or the wound may have been made with an instrument already carrying infectious matter. This latter mode is scarcely likely to be witnessed except in the case of post-mortem examinations of the bodies of persons who have died of plague; but probably it does happen, and much more frequently than is generally supposed, when a suctorial insect first punctures the skin of a person suffering from plague, and soon afterwards punctures the skin of a healthy person. But this way can be effectual only when the blood of the plague-patient carries bacilli into the circulatory vessels of the skin; and this it does only when the patient has either suffered from the septicæmic (or blood-poisoning) form of the disease from the beginning, or else is about to die and is within 24 hours of death. The septicæmic form is seen in a minority of cases in man (in 17 out of 303 at Sydney); on the other hand, it is the commonest form of the disease in rats. It is therefore necessary to ascertain if possible, exactly how the secondary cases in the 10 households acquired their disease, before concluding that they did not get it from the primary patient.

Nine

Nine of these households yielded two cases each, one of them yielded five cases. But the secondary cases occurred under very different circumstances, according to which the 10 households will be divided into three classes: (*a*) four in which the secondary cases occurred after separation from the primary patient and the house in which he had lain ill; (*b*) three in which the secondary cases occurred before removal to isolation; and (*c*) three in which the secondary cases occurred after return of the family to the house after the latter had been cleansed and disinfected, and before release of the primary patient in two of them. The following are the requisite and available details concerning the first group :—

Case 7, m. *æt.* 2; attacked March 8th; transferred to Sydney Hospital the same day; died early on the 10th. The family of two adults and five children was removed to isolation on the 10th. On March 11th, f., *æt.* 9, and m., *æt.* 5, were attacked; on the 13th, m., *æt.* 7, and during the night of the 13th to 14th, m., *æt.* 45; form, bubonic in all. All were indigenous.

Case 15, m., *æt.* 20; attacked March 11th; notified and removed to isolation, together with 18 on the 13th. Case 18, m., *æt.* 18, was attacked March 14th. These patients were brothers who lived together; they also worked at the same warehouse; form, bubonic in both.

Case 159, f., *æt.* 24; attacked April 23rd; died May 1st before removal. Case 177, f., *æt.* 4; attacked April 29th; form, bubonic in both. The house stood on the area indicated by a cluster of dots west of the five dots representing Case 7, and the cases were indigenous to it.

Case 161, m., *æt.* 15, was attacked April 28th; removed to isolation, together with 170, May 1st. Case 170, f., *æt.* 11, was attacked May 2nd; form, both bubonic. These two patients were brother and sister; they lived on the area last-mentioned above, and the cases were indigenous to it.

Case 7 could not have infected the other four, because the patient was taken to a public hospital as soon as he was attacked and left there; and notwithstanding the plague of fleas in the cottage (see p. 25), the latter could not have derived from him any infection they may have carried, because his case was bubonic, and because he was not near death at the time he was removed from their reach. Case 15 had all those opportunities of infecting 18, which their relationship and occupation of the same dwelling imply, and the interval between the attacks was just sufficiently long for communication to have taken place, but 15 was a bubonic case, and he recovered; on the other hand, both of these patients had been occupied immediately before and down to the attack of 15 in collecting dead rats, and in destroying live ones at the warehouse at which both were employed, and which had suddenly become overrun. 177 having been closely exposed to 159 during six days of the latter's illness, and having been attacked only a little more than 24 hours before 159's death, it is possible, and even likely, that the infection was communicated from 159 to 177. 161 had opportunity of infecting 170, and in this instance no source of infection was actually discovered; but the house they occupied stood on the Redfern secondary focus, and in accordance with the views already expressed hardly requires special explanation. While the details, then, do not positively exclude communication of the infection from the primary to the secondary cases, they do not conclusively point to it either; the first two instances, indeed, strongly indicate that the infection was received from a source common to primary and secondary cases alike.

If this interpretation be correct, then among so large a total number of households it is probable that there would be some in which the primary and secondary cases were either simultaneously attacked, or were attacked successively, but at a very short interval. There were three such occurrences, of which the requisite particulars are given below.

Case 84, m., *æt.* 3; attacked April 5th; died before removal April 7th. Case 85, f., *æt.* 30; attacked April 5th; form, bubonic in both. Mother and child; lived on the original focus.

Case 101, f., *æt.* 42; attacked April 8th; removed April 12th. Case 102, f., *æt.* 32; attacked April 7th; removed April 12th; form, bubonic in both.

Case 272, f., *æt.* 13; attacked June 8th. Case 273, m., *æt.* 41; attacked June 6th; form, bubonic in both. Father and daughter; both were removed June 13th. The house is represented by two contiguous blue spots on the Botany-road.

The first pair were simultaneously attacked, the second within twenty-four hours of each other; in neither could the infection have been communicated. There must have been a common source from which both took it. In fact, 84 and 85 lived at a public-house on the infected area, close to the waters of Darling Harbour; while 101 and 102 were fellow-servants at an hotel overrun with rats, of which many had died shortly before the dates mentioned. In the third pair communication was hardly possible; it cannot have been effected by inoculation (see p. 33) from 273, whose case was bubonic and ambulant; and if not so (but still communicated in some other way), attack of 272 could scarcely have followed within,

or

or just beyond, forty-eight hours of the attack of 273. And on the other hand, 273 was a cow-keeper, who had a large stock of fodder, in which a great number of dead rats was found by the disinfecting corps when they turned it over.

A still further test can be applied to the correctness of the interpretation put upon the facts recorded above. If, in those instances, primary and secondary cases alike owed their illness to a common source of infection, which consisted neither in infected human beings nor in infected goods, it must have inhered in some way in the premises; and, consequently, there should be instances in which the disease occurred among men who frequented premises on which no plague patient had ever lain ill, nor even had ever been while suffering. In the following Table several such instances are mentioned; the premises are places of business which were not places of residence, and which were frequented by the patients during the daytime only:—

TABLE XIII.—Showing places of business at which more than one case occurred among the workmen, and distinguishing those workmen who lived on uninfected areas.

Place of Business.	Position of Place of Business.	No. of each Case among the Workmen.	Area on which Patient lived—Infected or not.
1... ...	Kent-street	14	
,,... ...	,, ...	19	Not.
,,... ...	,, ...	21	
2... ...	,, ...	30	Not.
,,... ...	,, ...	31	
,,... ...	,, ...	41	Not.
3... ...	Pitt-street	87	
,,... ...	,, ...	168	Not.
4... ...	O'Connell-street	199	Not.
,,... ...	,, ...	207	
,,... ...	,, ...	214	
5... ...	Haymarket	99	
,,... ...	,, ...	225	Not.
6... ...	George and Clarence Streets	106	
,,... ...	,, ,, ...	149	
,,... ...	,, ,, ...	171	Not.
,,... ...	,, ,, ...	178	Not.
7... ...	George-street	33	Not.
,,... ...	,, ...	60	Not.
,,... ...	,, ...	69	Not.
8... ...	Clarence-street	36	Not.
,, ...	,, ...	40	
,,... ...	,, ...	44	Not.
,,... ...	,, ...	51	
9... ...	Castlereagh-street	91	Not.
,,... ...	,, ...	92	
,,... ...	,, ...	96	Not.
10... ...	Pitt-street	164	
,, ...	,, ...	189	
11... ...	George-street	131	
,, ...	,, ...	137	
12... ...	,, ...	246	
,, ...	,, ...	247	Not.
13... ...	Castlereagh-street, Redfern	150	
,, ...	,, ,, ...	193	
14... ...	Park-street	227	Not.
,, ...	,, ...	236	Not.
15... ...	Pitt-street	243	
,, ...	,, ...	264	
16... ...	King-street	67	
,, ...	,, ...	83	Not.
17... ...	Pyrmont	126	
,, ...	,, ...	302	

Only 17 such places yielded multiple cases, but to a total number of 43. 10 yielded 2, 5 yielded 3, and 2 yielded 4 cases each. As will be seen from the last column of the Table, the workmen who were attacked sometimes had their homes on areas regarded as infected in accordance with the method of judgment already described; they must be excepted, therefore, as owning (in the present relation) a doubtful place of infection. But at 12 of these premises, 3 patients in a total of 3, 2 in 3,

2 in 3; 2 in 4, and 2 in 4; 2 in 2, 1 in 2, 1 in 2, 1 in 2, and 1 in 2; 1 in 3, and 1 in 3, lived on areas to which no suspicion of infectivity ever attached. It seems by far the most probable that these cases were infected on the premises at which they worked during the day; and that being so, it is on the whole likely that the remainder were infected there also, though on this it is not necessary to lay stress. The only objection which can be raised to these examples when they are relied upon to show that infection was present on premises quite apart from man is this—they all stood on the area of severe infection defined above (see par. 3, p. 27); so that these workmen ran some daily risk in crossing it, and perhaps some more definite and greater risk during the dinner hour. But, as to the former, the whole outbreak negatives liability to contract the infection by merely passing along the streets, &c.; while as to the second, it is evident that if the infection had not habitually spread on erratic courses (as judged by occurrence of cases on individual premises) an infinitely larger number of such premises should have yielded cases than actually did so, for the 17 stood precisely on that part of the city which is given up to such establishments. Yet this argument must not be incautiously pressed; for these very cases show clearly that mere presence of the infection is not enough to ensure attack. Something further, and something not commonly existent, seems necessary to enable communication of the infection from the source to man; for when buildings, which daily receive from one hundred to several hundred workpeople are judged (on the evidence just mentioned) to be seats of infection, only an exceedingly small proportion of the latter are likely to contract the disease. This has already been pointed out in another connection (see p. 29); but, indeed, the experience of ordinary houses supports the same view, since the occurrence of single cases in them was the common rule.

Even yet the evidence which points to the conclusion that the infection was erratically diffused, and which can be drawn from this epidemic, is not quite complete. Usually disinfection of premises appeared to be thoroughly effective; as a rule no cases occurred on premises which had once been evacuated, disinfected, and cleansed and which were re-occupied after five days. But in the very small minority of 3 households out of 276 further cases did occur; and this is exactly what might be expected to happen if the infection did not (as it has hitherto been expressed) inhere in the house itself, but was present in a form which allowed of its withdrawal and return.

Case 50, f., *æt.* 15; attacked March 27th, removed March 30th, together with 186. The house and contents were disinfected, and the family resumed occupation April 6th. Case 50 was released April 21th, and returned home. Case 186, m., *æt.* 5, attacked May 3rd, removed May 5th. Form, bubonic in both. The house stood on the Redfern secondary focus, not far from case 7; 186 had not been away from the house and the street in which it stood since April 6th. There was no history of rats about the house.

Case 253, m., *æt.* 6; attacked May 23rd, removed May 30th, with 288; was released June 28th; the family returned June 5th. Case 288, f., *æt.* 5, attacked June 26th; form, bubonic in both; brother and sister; lived on the Manly focus.

Case 270, m., *æt.* 5, attacked June 4th, removed June 11th, released August 24th; the family returned June 16th. Case 296, f., *æt.* 12, attacked June 26th; form, bubonic in both; brother and sister; the house stood at Surry Hills, a neighbourhood infected by extension from the Redfern focus; the cases were indigenous to it. Case 270 had found a dead rat in the kitchen two or three days before attack, and the disinfecting corps discovered several others after raising the kitchen floor.

These three instances are not cited to show that the several houses did become reinfected from the outside after they had been cleansed and disinfected; for it is quite possible that the secondary cases acquired their infection at some neighbour's house to which they may have gone. They are mentioned merely as being consistent with the supposition that the source of infection was automatically transportable, and had reintroduced itself. It can be objected that if this were the true explanation such cases should have occurred much more frequently, whereas the fact is that the disease recurred on premises after they had been cleansed only 3 times in 276; but this is conjectural, and may be met by the reply that even when the infection certainly was present it by no means followed that it would be communicated to the inhabitants.

It appears then, from the foregoing considerations, that the infection attached to neighbourhoods; that it was encountered on premises, and usually in houses; that, as judged by the occurrence of cases in man, it fell erratically on the houses in any infected district; and that even when it was known to be present on premises

its

its communication to man was also erratic—or, at least, was effected much less commonly than might be expected in the case of this disease against which none of the population was protected. It is true that between March 12th (Case 14) and April 2nd (Case 67) 7,700 persons, and between May 11th (Case 215) and June 15th (Case 278) 2,700 more were inoculated, and that great efforts were made to restrict inoculation to those who lived on infected areas; but while this latter attempt largely failed, the total number of inoculations done in proportion to the number of persons living on or frequenting infected neighbourhoods, was far too small to account for the erratic incidence of the infection on the inhabitants or frequenters of infected premises; and, as a matter of fact, it was ascertained either not to have been received by any of the persons now referred to, or else to have been received by one here and there only. The observed behaviour of the infection, then, seems to require scrutiny with two points specially in view: the mode of its distribution in place, and the mode of its communication to man.

As to the mode of its distribution in place, it has already been remarked more than once that the only situation in which it was found (out of connection with the bodies of the sick) was in the bodies of sick and of dead rats. But that is hardly a fair statement which leaves the supposition open that it may have been present in a dozen other situations as well, but was merely not detected in them. The fact has been shown more or less fully (as regards man) that it did not exist effectively in soil, water, food, or fomites. Hence the known presence of the infection in rats points to these animals as the source from which man derived the disease. How the rats became infected is, doubtless, a question in relation to which possible infectivity of soil is of importance. But if it should be contended that the local rats received their infection thence, it must be shown first how into this virgin soil the infection came to be implanted; secondly, that having been implanted it could rest and even grow there. Now, if no case of plague in man preceded our Case 1, and if the soil became infected (if it were at all infected) otherwise than through ingress of sick rats, apparently this must have happened from communication of infection deposited on merchandise and thence transferred to the soil. Yet, while it has never been suggested that an intermediate stage of growth in soil is necessary, and while all pathological experience shows that it certainly is unnecessary (whether or not it be possible), it has been pointed out above that introduction of merchandise from infected into clean countries has never satisfactorily been shown to have communicated the infection to man, who is as susceptible to it as are rats. So it must be supposed that the infection in merchandise which did not communicate itself to rats on board ship, nor to man after it was landed, did communicate itself to rats on shore after an unnecessary, and in all probability hindering residence in soil. The merely practical consideration how the infection could probably be transferred from merchandise to soil under the usual conditions of packing, handling, and warehousing, need only be mentioned. It is manifestly most likely that the infection, if communicated to the soil at all, was so communicated by sick rats landed from a ship; but then, why should the soil-stage be imagined? Plague spreads from rat to rat in part, at all events, and with certainty, by the healthy feeding on the bodies of the dead. This is the way in which Loeffler's mouse-typhoid, and the disease of rats caused by Danysz' organism are spread, and in those cases is, perhaps, the only way—both being diseases caused by organisms which belong to the same group as *B. Pestis*. In short, the introduction of sick rats would seem to be an adequate and highly probable cause of the direct infection of local rats, while suggestion of the soil as a link seems unnecessary, and besides almost entirely lacks the requisite basis in observed facts.

The question whether Case 1 were the first case which occurred has little importance in relation to the epidemic (because this was not due either to direct or mediate infection from the sick), but may have some in relation to the epizoötic. Exceptionally in our experience, though certainly if suitable measures are employed, the infection is communicable from man to man by mediate means, and therefore may be communicated from man to rat: the following is the only instance which we met with, and it concerns man alone.

Case 262, m., *æt.* 22, engaged March 8th as scavenger at the Maritime Quarantine Station.

May 30th, at 6·30 p.m., went to lie down as usual before beginning his night duty, and afterwards had shivering, nausea, and headache; slept.

May 31st.—Awoke feeling well, but had slight diarrhœa; continued well all day; in the evening headache came on again; it lasted an hour only. Did his work during the night.

June 1st.—Was thirsty all day; went to his work at night.

June 2nd.—Was obliged to give up work at 4·30 a.m. Reported himself sick at 11·30 a.m.; was admitted to hospital at 2 p.m. On examination, temperature 98°·8, face flushed, eyes suffused, but not markedly; pulse slightly quickened, and of normal tension. A swollen gland the size of a large almond, and very tender, in right axilla; less enlargement of three or four cervical glands behind the sterno-cleido-mastoid muscle, which were not tender. 40/c/c. Yersin-Roux serum subcutaneously.

June 28.—Returned to duty.

The progress of the case calls for no special remark. The patient began to recover soon after admission. Liquid was withdrawn from the axillary gland (probably on June 5th) and microscopically examined on June 7th, with a negative result as regards *B. Pestis*, but streptococci were present. None of the enlarged glands suppurated. In the opinion of three experienced medical men who examined the case on or shortly after admission, there was no doubt the illness was plague.

On May 22nd the patient had received at the gate of the hospital enclosure the coffined bodies of two plague patients. These bodies had, as usual, been wrapped in a sheet wet with sublimate solution, and placed in a coffin having water-tight joints, by wardsmen; the coffins were then screwed down, wrapped in a cloth wet with sublimate solution, and handed to the patient, who helped the sexton to wheel them to the burying-ground. His other duties consisted in scavenging refuse and night-soil from all parts of the Station, except the hospital enclosure, but including the convalescent quarters; this he did during the night, and he never came into personal contact with the convalescent patients. He had on his right hand six grazes which were scabbed over, and which seemed not to have healed as quickly as such slight injuries should; he had also several horizontal cracks in the skin of the right fore-finger.

On the whole, the above account cannot be accepted as proof of mediate infection (inoculation of infectious material, perhaps from dressings discarded by convalescents); but the case was diagnosed as plague by gentlemen who at that date had had very considerable experience, and apparently inoculation could have come about only in some such way.

At this date, then—namely, more than nine months after the recognition of Case 1—it is still the general opinion that no other case in man preceded it. A comparison of the rates of death under causes in corresponding months of previous years disclosed rather smaller rates than usual. A stronger argument (because there is no reason whatever for suspecting that unobserved plague caused such fatality as would impress the returns with unusual features) can be deduced from the general proficiency and public spirit of the medical profession of Sydney; from the population being either of immediate European descent, or at the older ages actually of European birth in considerable proportion, and almost entirely British; from the ease with which medical advice can be obtained, and the universal habit of seeking it on occasion; from the number of friendly or provident societies; from the number, size, and accessibility of the public hospitals, as well as of other institutions where gratuitous medical advice is either available or whence applicants are directed to other places where it is furnished. Under these circumstances the presence of plague in New Caledonia became known, and placed the medical profession on its guard a month before Case 1 occurred (and effectually, as the instant report of Case 1 itself shows); while after the published identification of that case a whole month elapsed before the occurrence of Case 2, though in the interval suspected cases were referred for diagnosis. It is, nevertheless, possible, of course, that one or more unrecognised cases did occur; but to assume this seems as unnecessary as does the assumption that the epizoötic sprang, not directly from infected rats, but in a roundabout way from some unidentified source through the soil. At the same time, the possibility that the epizoötic arose from communication of the infection to rats (perhaps in sewers) through the infected excreta of an unknown case in man cannot be excluded, for no demonstration is or can be possible. It is perfectly clear, however, that Case 1 followed, and did not precede, the epizoötic; while reason has been shown for asserting that Case 1 actually did receive his infection from a rat. That reason will appear the stronger to those who are well acquainted with the investigations of Dr. P. L. G. Simond, *Médicin Principal des Colonies Françaises*, and who have observed that they explain and bring into accord many apparently dissociated or even opposed facts recorded of plague.

Admitting, then, that the source of infection for the local rats cannot be demonstrated to have been infected foreign rats, but asserting on ætiological and general grounds that this origin is almost infinitely probable, it must be enquired whether the observed distribution of plague rats in Sydney was sufficiently wide to account for the epidemic. It has been subsumed throughout the foregoing pages that man was usually infected by rats; whether it actually were so or not, was it possible?

On diagram B certain dates are inserted in red ink, some of which are underlined. They indicate some of the neighbourhoods in which diseased or dead rats were discovered. The under-score means that plague was demonstrated in the rats indicated by microscopical, cultural, and inoculation tests conducted in the laboratories. Where there is no under-score the note means that dead rats in numbers had been seen by some member of the staff, under circumstances which denoted death by disease, not by poison; very often (in 70 infected houses) the report was received from the disinfecting corps by which the bodies had been (and often had first been) discovered. It was rather commonly the case that the members of infected households had nothing to report concerning presence of rats alive or dead on the premises where these animals and their bodies were found on proper search. In one case (Queen-street, Woollahra) the infected animal was a cat; it was forwarded by Dr. W. H. Quaife, and was the only one of 5 received at the laboratory which had plague. No case of illness occurred in the house whence it came, which stood, however, on an infected area. Of 6 house-mice received, 2 had plague. The total number of rats examined at the laboratories was 167, of which 50 were alive; 10 of these were sick, and 4 of the sick rats had plague; of the 117 dead rats, many of which were putrid, 19 were shown to have had plague (see Appendix A, p. 53). The infected animals came from widely-separated localities within the city of Sydney where 41·5 per cent. of the total cases occurred; and two of them from the distant suburbs, Manly and Woollahra. These 23 are all the instances in which plague was rigidly demonstrated in animals; but very many rats were examined which there was no reason to doubt had also died of plague.

The above is the recorded evidence that rats over a considerable area of Sydney, which was the area on which cases of plague in man occurred, suffered from an epizoötic; and that this epizoötic (which began before plague in man occurred, and ceased, as far as can be learnt, about the same time as the epidemic ceased) was plague. In practice, however, many reports of dead rats, and of the sudden invasion of premises by rats where none had been before, which were commonly made during continuance of the epidemic were taken as supplementing the evidence already given; and it would be erroneous to suppose that the recorded and rigidly proved instances were the only ones which were credible. This was far from being the case; and if it be desirable that many more well-established observations should have been recorded—as, undoubtedly, it is—it is also the case that our resources were not adequate to furnish a separate staff to watch over the epidemiological features of this outbreak. What was possible was done

In short, that the infection was disseminated by rats appears tolerably certain, and it may not be too much to surmise that plague is primarily a disease of the rat which is communicable to some other animals, among which man happens to be included. The real difficulty is encountered when an explanation of the way in which it was communicated from rats to man is sought. It must be remembered that the prevalent opinion now is that, generally speaking, man contracts plague by inoculation. A rat might well disseminate the infection on the air by sneezing, since it is found on the nasal mucous membrane of rats; but this, perhaps, would produce the primary pneumonic form in man—not a common form in any epidemic, and, with a single doubtful exception, not seen during the Sydney epidemic. A rat might also disseminate it with its excreta; but, if this should suffice to bring it within striking distance of man sufficiently often to cause epidemic prevalence of a practically non-infectious disease (in the common bubonic and the less common septicæmic forms), it must operate usually by contamination of food or of articles other than food. As to food man rarely (if ever), as a matter of fact, gets the disease by ingestion. Many an article might be soiled with the infection without causing inoculation or, rather, few articles so soiled are capable of inflicting a wound, and still less often are likely to enter into the circumstances which would afford the necessary opportunity; but there is certainly one exception. If hay became the medium for deposited infection any person handling it would be very likely to receive the slight wound which alone is necessary to inoculation; but hay is just as likely to carry the rats themselves, dead or alive. After all, however, this accident could not occur often enough to be of importance in causation of an epidemic, and the opportunity is taken to mention it merely because it affords a possible explanation of Cases 4 and 272-3 as well, perhaps, as of some others of those which are classed in Table X as employed at produce stores. But case 273, p. 35, hints another and simpler interpretation.

The

The means of inoculation must be one commonly in operation in order to be an efficient cause of epidemics. Hence the observed preponderance of bubonic enlargement of the glands of the groin, which indicates entry of the infection at some part of the lower extremity, and which has been observed in the barefooted populations of the East, is often ascribed to the wounds which unprotected feet receive. It may even be surmised that the notion of spread of the infection mediately through the soil has received some unacknowledged support from this theory. But the facts do not at all warrant it. The preponderance of groin buboes at Sydney was as striking as in any other part of the world. Among the total 303 cases there were 17 which had no bubo; in the remaining 286 cases the bubo occupied the right inguino-femoral region in 99, the left in 101, and it was bilateral in 9; making altogether 209 in which the bubo occurred in the inguino-femoral region and no where else, or 73 per cent. of all those which showed buboes at all. Yet the inhabitants of Sydney, and those among them who were attacked, no more go barefoot than do the inhabitants of London. They live in a sub-tropical climate, but their habits in all matters of dress are still entirely those of the people of northern Europe.

Needless, however, to beat about the bush. Granting that plague in man is usually the result of inoculation, the manner in which this can be brought about on a sufficient scale to account for an epidemic would remain hidden but for the observations of Dr. P. L. G. Simond, already referred to. A sufficient account of the leading points in his teaching appears in Appendix A, p. 56, and need not be repeated here; but to appreciate the weight of his observations his original paper must of course be studied. He considers that plague is most often communicated to man by fleas which, after feeding on plague rats, become transferred to man whom they inoculate. Thus also, he thinks, is the disease sometimes conveyed from rat to rat and to other susceptible animals. The minute puncture usually leaves no mark, but in a small proportion of cases it produces a phlyctenule or a bleb. Such a lesion was observed in seven of our cases; excepting Case 1 it appeared as a small papule, surmounted with a minute vesicle; from two of these in two different cases smears were made; in one of the smears bacilli morphologically resembling *B. Pestis* were demonstrated. It is not to be supposed that all our cases were searched with this object in view; many were, and the six formed but a small proportion of the total examined, but a quite systematic and quite thorough search could not be carried out in all cases. Several fleas taken from infected rats were examined; in one a bacillus resembling *B. Pestis* was demonstrated, and it was identified by the result of inoculation into a guinea-pig.

Nine fleas taken from rats received at the laboratories were referred to the Government Entomologist (Mr. Walter. W. Froggatt) for classification. Mr. Froggatt reported upon them as follows:—

Slide No. 2 Dog-flea (*Pulex Serraticeps, Germ*). This is our common cat and dog flea, and has been described under the name *P. Canis* and *P. Felis*. These specimens do not exactly agree with my typical form (which was caught in the office), as the teeth-like spines on the lower edge of the head are absent, but this may be a variation in the sexes. The dog flea is the common house-flea in the United States, *P. Irritans* being a rare species with them, and seldom found. "Examination of many specimens of fleas sent to the Department in recent years shows that the species which commonly overruns houses during damp summers in our eastern cities at least, is not, as many have supposed, the human flea, but the common cosmopolitan flea of the dog and cat." (L. O. Howard, in Bulletin No. 4, division of Entomology, U.S. Department of Agriculture, 1896, p. 24).

Slide No. 3. This slide contains 3 specimens; one, the largest, is another specimen of *P. Serraticeps;* the 2 small ones are rat-fleas (*P. Fasciatus, Bosc.*)

Slide No. 4. Rat-flea (*P. Fasciatus, Bosc.*) Slide No. 5. Three specimens of the same.

P. Fasciatus was of the most usual brown colour. *P. Serraticeps* is said by Neumann not to bite man; but this is not in accord with general experience, and would seem from the reference furnished by Mr. Froggatt not to be the case in the United States. Whether *P. Fasciatus* will bite man is not known here; no experiments to test this point were tried during the epidemic. As Dr. Frank Tidswell has suggested, it is likely enough that varieties which will not, or do not, commonly infest houses and man, may yet bite once when they find themselves on the human body. *P. Serraticeps*, however, which certainly does bite man, was found on two of the small number of rats thus examined.

The

The teaching of the foregoing study of plague as it appeared at Sydney, seems to be as follows :—

1. The disease was not directly communicated from the sick to the well—in other words was not "catching."

2. It was not communicated in any important degree, at all events, from the sick to the well by mediate channels (clothes, household goods, merchandise, excreta).

3. The infection attached to localities, and spread to others adjoining and continuous with that in which it was first manifested.

4. It also spread in a fashion which betokens the possibility of its being transported mechanically from an existent focus to a considerable distance (Moore Park garbage-tip and Manly), and there initiating an independent focus.

5. In the buildings on any infected locality cases occurred irregularly, and showed no special proneness to occur in adjoining houses.

6. When the occurrence of one case among the inhabitants of a building showed that the infection was present in it, secondary cases rarely followed. Irregularity of incidence on houses was accompanied with irregularity of incidence on the inmates.

7. An epizoötic disease among rats preceded the first case which occurred in man.

8. This epizoötic disease was plague.

9. The area over which the epizoötic extended was practically co-extensive with that on which cases of plague in man were observed.

10. The epizoötic died out as far as can be learned at the same time as the epidemic ceased.

11. The epidemic was caused by communication of the infection from rats to man.

VII.—Prevention.

It will appear ultimately that the best protection against epidemic plague lies in sufficient sanitary laws, persistently and faithfully executed by Local Authorities during absence of the disease, and that no other general scheme of defence is practicable.

Successful prevention of epidemic diseases depends entirely on knowledge of their nature, of their causes, and of the means by which the latter are diffused. On these points our experience has shed useful light, though many details remain to be worked out—some in the laboratory, some in the field ; while others still require, and now urgently demand, assistance from those who profess correlated branches of science. In such circumstances practical management of a present epidemic cannot proceed unless certain assumptions are made; and it is worth while to point out here that rational assumptions which coördinate and explain accurately observed facts have nothing in common with guesses. Accordingly, the following remarks are made in view of the facts and inferences recorded above, and with reference to epidemic plague in the bubonic form.

The prevention of epidemic plague might be discussed under the three heads importation, local diffusion, and exportation. Under importation fall international notification, arrest of infected persons and things, and destruction of rats afloat. Under local diffusion fall care of the sick, care of contacts, protective inoculation, exclusion of rats from dwellings and the immediate neighbourhood of man, destruction of rats, destruction of human parasites, cleansing and disinfection. Under exportation fall the steps which can practically be taken with hope of preventing diffusion of the disease from infected spots (*a*) to clean places within the same country, and (*b*) to clean places beyond its borders. It will not be convenient to take these subjects exactly in the above order. It will be best to inquire first who may properly be designated "contacts," and how these persons should be treated.

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The term is much in use; it has a certain convenience, but unfortunately no defined meaning. Probably it was devised to indicate those who had recently been in close association with the sick; and were it so employed in connection with smallpox, for instance (which is maintained and diffused exclusively by communication of the infection from the sick to the healthy), it would be not merely useful, but sufficiently exact. But in the present connection it is inaccurate. As we have now learned, bubonic plague and smallpox do not become epidemic by the same means; our epidemic was not caused or maintained by communication of the infection from the sick to healthy human beings, either mediately or directly. As long, then, as the word "contact" is used with reference to preventive measures, of which one is obviously indicated by it, it does not necessarily apply to those who have been recently associated with persons who are actually suffering from plague. On the other hand, our experience has shown that infectiveness attaches to localities; so that "contact" might properly be used to designate a person who had lived on, or who had been exposed to the influence of, an infective locality; and he would deserve this distinctive epithet for five days after he had been completely separated from that place, because the infection (if it has been taken) reveals itself within that period in occurrence of the disease. But our experience has further taught that local infectivity is not due to any inherent peculiarity (attaching, for example, to the soil), but merely to the casual presence of plague-rats. So a "contact" is one who has been more or less closely associated with plague-rats.

The other persons living in any house which contains a plague-stricken human being, then, may or may not be "contacts." The presence of the patient is evidence merely that he has at some time been a "contact" himself within the meaning of the definition, but it predicates nothing of the rest of the household. Effective exposure to the infection (inoculation) must necessarily be little more than momentary; so that no person who moved about up to the time of his attack can be assumed to have received the infection either at that place where he lives and is found or at those other places which he frequented. In point of fact it has been shown that the place of infection was sometimes not the dwelling, but the workshop; and, on the other hand, that it was sometimes not the workshop, but precisely the place of residence. In short, the first hint that infection is somewhere to be encountered usually consists in occurrence of the disease; and this only furnishes occasion for inquiring where it was encountered. The search will naturally begin with the patient's immediate surroundings, but often these furnish no clue; it must be continued to distant places frequented by him, and there the source may be found.

It is plain, therefore, that no general rule according to which all those who are found in contact with a plague patient shall be dealt with can be laid down, and that the attempt to enforce such a rule will not only lead to injustice in a majority of the cases submitted to it, but must unnecessarily embarrass the central health authority; more than that, it would be found practically impossible to adhere to it in the case of many business establishments, such as banks, public Departments, and the like. Each case must be treated according to the known facts of the place or places concerned, and the general features of the epidemic. What these are is always much better known to the central health authority than to any other party, for it has (and, if it be properly organised, it alone can have) possession of the information on which a prudent judgment can be based; it is, additionally, the most competent interpreter of the facts within its knowledge. The central health authority will be most wisely left absolutely free to take such measures to control the epidemic as to it seem best; much more, therefore, should it be left absolutely free to deal as it thinks most prudent with individual premises and the persons associated with the patient. It is also obviously necessary that its decisions be accepted as final and unquestionable. Every other course must result in increase of public agitation, in unnecessary expenditure, and in great risk of prolonging the visitation.

Secondly, it is convenient to inquire how the sick themselves should be dealt with. It has now been said many times that the epidemic was not maintained either by direct or mediate communication of the infection from man, and it has doubtless seemed—and very naturally seemed—that no better reason for leaving the sick where they are found could be given. But true though the statement be, this inference would be false. Plague is a disease common to man and to rats; whether it be primarily a disease of rats or not is of little immediate importance.

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It can be communicated from rats to men, and from men to rats by suitable means—the word "suitable" in this connection meaning "by inoculation," though as regards rats only it includes also feeding on plague-rats. Those are the facts of such communication experimentally ascertained; it is probable also, but not ascertained, that the disease can be communicated from man to rat in other ways—namely, through the infective matters cast off from the diseased human body. Indian records are not devoid of instances which suggest that this may occasionally have been the true sequence of events in a few localities; and therefore, although they scarcely amount to proof, and although (it is believed) communication of the disease to rats by such means has not been demonstrated to be an experimental possibility, yet there is ample reason for collecting everything which proceeds from the infected human body and for destroying it, or at least for rendering it non-infectious by one or other of those means which are known to be efficacious. Now, a central health authority, charged with the heavy responsibilities which attach to management of an epidemic of plague, would be imprudent which left the precautions just mentioned to be taken by the members of individual households, whatever their resources might be. All of the sick should be removed at the earliest possible moment to an isolation hospital strictly managed under immediate direction of the central health authority; but cases occur in which no isolation hospital exists within reach, and some others in which ample means and the isolated situation of the houses in which they occur render it not absolutely necessary to remove the patient. In all such cases the central health authority may leave him at home, but only on condition that he is nursed by nurses in its employment and under direction (in all matters relating to prevention of spread of the infection) of a member of its own medical staff. On the whole, though extreme care is in every case necessary, greater care, if possible, would appear to be requisite with houses connected to a sewerage system than with others.

Thus, for the present at all events, every actual case of plague must be regarded as a danger to the whole community; and therefore, in connection with the question whether the sick must be isolated, attention should be drawn to the fact that plague is communicable from man to man both by direct and mediate channels, although our epidemic was not maintained by such communication. Primary plague pneumonia is directly communicable to man; and further, whatever the form of plague may be in which a case of the disease begins, secondary plague pneumonia is liable to supervene. The patient's expectorations then carry the bacillus, and therefore are probably dangerous. Additionally, the excreta, both solid and liquid, sometimes (with unascertained frequency) also carry the bacillus; this happens at all events when the minute hæmorrhages into the submucous coats escape into hollow organs, and possibly under other circumstances; while the discharge from bubonic abscesses always carries the bacillus in profusion at first, and on very good authority is said to continue to carry it in viable (though not necessarily in virulent) form for many days. Lastly, in almost all septicæmic cases, and in many others of whatever form when death impends, bacilli are easily found in profusion in the general blood-stream, even in the capillary vessels of the skin, and from the latter the infection can be abstracted by suctorial insects (fleas and bugs), and may be inoculated by them into the healthy, or into rats. So that for the sake of preventing as much as possible occasional communication of the disease from the sick to others associated with them, and largely for the sake of diminishing the risk of infection of rats from cases in human beings, and of rendering control of those risks more easy and certain, all plague-cases in man must be isolated under immediate direction of the central health authority; and in the vast majority of cases it will be not only expedient, but necessary, to effect this by transfer to hospital. In view of the rare exceptions which will be met with, the central health authority must be left absolutely free to decide what shall be done in each case on its merits, and, again, its decisions must be accepted as final, and must be unquestionable. The fears and fancies which preoccupy the mind of the general public on such occasions, and the dicta of those among them who rely for guidance on common sense, cause confusion, sap confidence, favour panic, and pave the way for disaster.

International notification of plague has its uses, although the information thus communicated comes too late to set in motion those preventive measures which would prevent importation—if they ever could be thoroughly effectual. It is not customary to notify the presence of plague unless there is good reason to consider it

epidemic

epidemic. But, which is of more 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 epizoötic; and the real danger to the importing country lies with plague-rats, not with plague-stricken men. Evidently notification, as at present understood and practised, cannot much help in preventing importation of plague.

It is hardly possible to conceive how a measure taken to prevent the risk of importing plague-rats could be made dependent on notification of disease among rats at the port of departure; besides which the defences of that country which relies on other countries for aid in raising them are likely to be inefficient. Were the fullest information always available in time, which it never could be, the object would be to kill all the rats—not a majority, but all of them must be destroyed—on every incoming vessel; and this could be done in practice only by landing cargo on a small island, overhauling it, treating the hull, and reloading the vessel before allowing it to approach the quays. But there can be little doubt that this is impracticable. It is possible to kill many rats on laden vessels; though at the best it must always remain doubtful whether all have been killed, and a difficulty arises in connection with damage to cargo. Experience has led us to rely on sulphur fumes.

Rats will not venture where there is the least smell of sulphur dioxide, and they are easily killed by respiring air which contains a moderate proportion of it. The practical use which has been made of these facts, is the following:—Small quantities of sulphur are burned on upper decks, &c., being only enough to taint the air rather strongly; this not merely causes rats to retire to the lower parts, but seems sufficient to prevent them from returning even when the next stage of the process is in full swing. This consists in closing holds, bunkers, &c., &c., by the usual means, and in then burning sulphur in the estimated proportion of about 2 lb. to every 1,000 cubic feet of unoccupied space. The exposure should last not less than six hours. This plan is effectual, though there is reason to think it is not always completely so. It is easily managed, and the only objection to it is damage to some kinds of cargo by taint of sulphurous acid. It has already been mentioned that as many as 287 dead rats were gathered from a small steamer after fumigating it in the above-mentioned manner; and at Newcastle where vessels generally arrive in ballast to load coal, or else carrying a moderate load (say up to 1,000 tons) of general cargo for the most part cased, the number thus destroyed has varied from a few to a "tubful". As a matter of fact, no serious complaint of damage to cargo has been made; but vessels from New Caledonia ceased to bring coffee during continuance of these precautions which, it was thought, would be unmerchantable after fumigation with sulphur. The alternatives to sulphur appear to be formaldehyde and carbon dioxide, both of which were suggested at an early date. As to the former, its practical use requires more careful management than available fumigators can be relied upon for; errors and omissions can seldom be made good by a second operation, for although shipowners submit willingly enough to a detention of known duration, they expect the time to be utilised in a businesslike way. Formaldehyde is, moreover, expensive. Carbon dioxide appears a more promising agent, but it has serious drawbacks. In the first place it does not favour collection of living rats in holds and bilges where alone this gas would in all probability collect in sufficient proportions to kill, and if perceived by the rats it would be easily evaded by them. As to disengaging it in the required quantity and with the requisite promptitude, this could only be effected with cylinders of the compressed gas; but those who have used them are aware of the practical difficulties which are encountered. The gas might be disengaged from chalk and muriatic acid; but it happens that the Department has had some practical experience of this method in connection with the killing of stray dogs by the police, and the result of the experiments conducted by the Government Analyst (Mr. W. M. Hamlet, F.I.C., F.C.S.) precluded all thought of attempting to employ this plan on shipboard. On the whole, our experience has shown us that sulphur dioxide is the only agent practically useful for the present purpose, notwithstanding some drawbacks.

But we have learned more than this, which leaves the cargo difficulty (in practice not important with us) untouched. It would be much better not to have rats on board ship, than to attempt to kill them off on laden vessels; and there is not much difficulty in keeping them away. The method is to fumigate the vessels with sulphur while empty, or nearly empty, at the beginning and end of voyages. According to the reports furnished by the Superintendent of Fumigation (Captain G. Tait) it appears that if vessels which engage in coasting voyages lasting about three weeks, or from that to a month, are fumigated at the port of departure before loading, and at the ultimate port touched on the voyage (when they usually have some cargo on board), few and often no rats are discovered after the next fumigation done on return to the port of departure before commencing a fresh voyage. This statement applies to steam-vessels of various tonnages up to about 4,000. The method has been practically carried out under intercolonial agreement, which requires that such vessels shall produce a certificate of fumigation while empty at the port of departure, and at the ultimate port of the voyage, without which they are not allowed to communicate with the shore except after a prohibitory detention at quarantine.

In conjunction with this precaution, which might well be adopted under an international agreement, others, designed to prevent intercommunication between shore and ship rats while lying at quays, should be adopted. These consist essentially in

in the use of shields on springs and hawsers, in fending off vessels from quays, or in hauling off at nightfall, in closing openings in the sides, and in hauling up gangways at night unless in actual use, in illuminating the quay and the ship's side, and in providing watchmen.

Lastly, quays must be properly constructed—that is to say, they must terminate in a solid sea-wall of masonry or concrete at a point below low-water mark, so that wharves built out always have water beneath them. The wharves at Darling Harbour, which were the starting-point of the epidemic, are very old, and everything which wharves should not be. They consist of staging carried out over the foreshores, the quay wall being sometimes barely within reach of high water, and constructed either of seriously defective rubblework, or else of sheet-piling in bad order and filled in behind with large stones. Both afford ample harbour for rats, which were found to exist there in great numbers, while the mudbanks which are exposed at low tide and the piles which support the wharf-deckings collected and retained the dead animals and heaps of organic wastes, which insufficient scavenging and defective supervision caused to be thrown into the water. These faults will now be remedied in course of time under the Darling Harbour Resumption Act, and the Harbour Trust established by it, and this part of Darling Harbour will be reconstructed to resemble other parts which are already built in the manner recommended above.

While very much can be done to impede entry of plague-rats by the means described, which, therefore, should be adopted and steadily used, it is evidently unlikely that they can prevent such entry, or, in other words, be at all times completely effectual. Failure in connection with a single vessel, even though partial only, the entry of a single plague-rat to the rat community ashore is all that is necessary to originate an epizoötic of plague: and this is likely to occur, first, because all the described precautions can hardly be continuously taken; secondly, because information of the occasion for taking them is usually received after the risk has been run; and, thirdly, because of the unavoidable uncertainty of their effect when they have been taken. We pass on, then, to consider what should be done to control a present epidemic, and what should be done ashore to render recurrence of it as difficult as possible.

During an epidemic the only proceeding of much value is destruction of rats and of their nests, burrows, and habitual haunts, and those others which are calculated to prevent access of surviving rats to proximity with human beings—in other words, to expel them from occupied premises, and to keep them outside. This measure was given a first place in the precautions recommended to householders in the pamphlet issued from the Department on March 1st (Appendix H, p. 75), and, on the whole, subsequent experience may be said to have established its usefulness. It is true, no doubt, that several people were infected at wharves, and four others in the course of scavenging infected areas (though whether within or outside dwellings does not appear) but the great majority were infected on premises. On premises where indigenous cases had occurred, moreover, the presence of freshly-deceased rats was discovered quite often enough to support the general proposition that the danger of contracting plague stood in relation to the presence of rats in dwellings or enclosed premises. A general slaughter of rats would answer the purpose, if it could be carried out quickly, and with tolerable completeness; but that is practically impossible.

Slaughter of rats was attempted by us, and doubtless should always be attempted. The following steps were taken:—The City Council, within whose district the epidemic commenced and fell most heavily, early instituted a special rat-catching staff, and ultimately reported that it had destroyed 38,600; the business was then taken over by the Government. A considerable staff of rat-catchers was employed, who worked according to indications furnished by the Department, or else from observation; a capitation fee of 2d., subsequently raised as already described to 6d., was paid for the body of every rat brought in by the public; depôts at which rats were received, paid for and burned, were established at various points in the suburbs; municipal councils were gratuitously supplied with rat-poison for distribution among their ratepayers, and with a man to distribute it, and to exhort the people to lay it; the Board of Water Supply and Sewerage, fumigated the sewers with sulphur in a systematic way; officers in charge of public buildings were instructed to take similar measures; and many private firms, including owners of wharves and steamships, as well as private householders, dealt with their own property. There was delay in commencing the destruction of rats on a scale likely to be at all useful. It was only seriously attempted after the public attention had been aroused by a last appeal made by the Department on April 9th, when the 96th case had already occurred. It is difficult to estimate the effect on the rat population which was produced. The total recorded number of rats killed by the Government staff between April 18th and October

October 31st was, in the city, 56,136; in the suburbs, 13,572; total, 69,708. To this must be added the number claimed to have been killed by the local authority for the city, namely, 38,600, making a recorded grand total of 108,308. Private persons probably killed a considerable additional number; and many were killed by the scavenging staff in the course of its operations.

On April 3rd the Water and Sewerage Board commenced fumigating the sewers. Within the city of Sydney, though many intercepting sewers have been constructed by the Board which are in all respects in good order, the greater part of the district is still served by very old and ill-constructed sewers; and the house-connections are, in the case of about 20–21,000 houses out of 22,000, improper, imperfect, and dangerous. Outside the city all sewers have been constructed by the Board; these in themselves and in their connections are what they should be. In the first place, then, the general statement may be made that probably very few rats existed in the new sewers, but great numbers in the old ones. While the new sewers afford them no lodgement, the outfalls discharge either into deep water or on well-tended filtration areas or sewage farms; while the old city sewers are too often accessible from harbour foreshores. The method adopted was either to blow the fumes of sulphur into them, or to burn sulphur in trays suspended beneath manholes; afterwards they were flushed with water to wash down the dead rats. The result, gathered from the reports regularly issued by the Board, cannot be expressed in numbers. From the new sewers very few carcases were got; from the old sewers large numbers were washed down (at all events at commencement of these operations), and it is believed that many must have been killed which never were seen. As a matter of fact only between 300 and 400 were actually gathered by the workmen employed, but, as just mentioned, this does not bear any definite relation to the numbers actually killed and seen, though not collected. In the city an incidental and useful effect of the fumigation was to fix the position of many faults in the old system, through which the fumes escaped so as to be strongly perceived within houses, and even in the open.

Employment of the organism used by Professor Loeffler to destroy mice had at an early date been recommended in letters to the daily papers for the destruction of rats. The Department, however, had investigated this matter at great length two years earlier in relation to its proposed use for destroying flying-foxes (see Annual Report of the Board of Health for the year 1898), and had subsequently extended the inquiry to ascertain its powers and usefulness for the destruction of rats both in the laboratory and in the field. The results showed that while the scattering of bait impregnated with broth cultures of Loeffler's *B. Typhi Murium* often resulted in disappearance of rats from their old haunts, very few sick rats were ever seen and no dead bodies were ever found; while in one locality unmistakable evidence was got that the infection of a few animals was immediately followed by retirement of the whole horde to some neighbouring spot not far distant, where it lived in good health.

Cultures of Danysz' organism, recommended by the discoverer for destruction of both rats and mice, had been cabled for at beginning of the year, in consequence of an account of its apparent effects which had been communicated to the President by a *confrére* in New Caledonia. As soon as they arrived (May 3rd) this organism also was examined in the laboratory and tested in the field, without any useful result being attained. At a later date Danysz' own account of the organism was published, from which it appeared that the disease caused by it spread only to rats which fed on the bodies of rats killed by eating the original bait, and that it was not alleged to cause a disease freely communicable in other ways, such as seems to be requisite to its effectiveness in the desired direction.

Nevertheless, it is likely enough that an impression was produced on rats in certain districts, and in as far as such districts were infected that impression was useful. It can have been useful, however, only to the inhabitants; for rats flee as soon as they are persistently disturbed, and partly (only) for this reason the infected rats spread beyond that area on which the epizoötic first appeared. This danger was recognised by the public, which desired that before attempts at destroying rats in an infected district were made the locality should be surrounded by a fence to prevent their dispersion. This, as well as many another suggestion of a different kind, was made at a comparatively late stage of the epidemic—at a time, at all events, when alarm had rendered it possible to secure public approval for almost any proceeding, however inconvenient, expensive, or oppressive it might be; and it is necessary to point this out because, even at the date when it might have been tried, it would no longer have been useful. Without discussing the question whether any fence which could be erected in a large city would have the desired effect, the fact was that before they were disturbed by efforts made to destroy them, infected rats had spread far beyond any such restricted area as could be fenced. This had happened in accordance with the instinct which causes rats to desert places where disease attacks them, or where poison is effectually laid for them. Case 7 (March 8th), it has been shown above, was infected where the patient was found, at a distance of about 2 miles from Darling Harbour; while the occurence of Case 15 showed that plague-rats had already invaded premises as far away from the shore line as York-street by March 13th. Other instances could be mentioned; but, in short, while it was sufficiently difficult to watch the progress of the epidemic in man, it was quite impossible to observe extension of the disease among rats. The conclusion as to rat-fencing is that it is one of those measures which would be useful if only they were practicable, while the conclusion as to rat-killing is that it may be useful and should be persevered with, but that it can never be more than an assistant means, and never can be a preventive. A better defence must be looked for in other directions.

What

What this is has already been mentioned. Importation of plague-rats may be impeded if good fortune accompany care, but in the long run it cannot be prevented. Rats ashore may be killed in large numbers, but it is hardly possible to suppose that they might be exterminated; besides, the epizoötic will usually have made considerable headway before the disease has been communicated to man, and, therefore, before it has been noticed. In the meantime, the rats will have scattered widely, not in consequence of attempts to destroy them, but of their own motion, and in accordance with those habits which are commonly known to cause them to leave any place where they find their companions dying. Under these apparently hopeless circumstances, examination of the facts of the late epidemic show that the infection was practically always taken on premises. This was only learned from careful observation, record, and consideration of all the facts of the outbreak; but, having been pointed out, the deduction from it is obvious. It is that the important practical protection against epidemic plague consists in removal of all those conditions which favour the harbourage, feeding, and breeding of rats in the immediate neighbourhood of occupied premises, and in excluding rats from dwellings.

This mode of defence is no sooner mentioned than it is seen to be practicable; and not merely so, but to be attainable by the steady and faithful execution of the elementary details of municipal sanitation. The places in which rats live and breed are the dark and intricate recesses which exist about ill-constructed or decaying structures; heaps of household refuse, which afford warmth, and in which they burrow; ill-made basements, cellars, and store-rooms, where defective flooring is supported above the natural soil; stables and dungheaps. The conditions which attract and retain them are the presence or near neighbourhood of food; if (as is usually the case) they are to be met with in hardware and soft goods stores which have been ill-constructed or which have fallen into disrepair, they are more constantly found in butchers' shops, produce stores, grocers' shops, public houses, hotels, and kitchens; and are always to be seen at night in lanes and rights-of-way, however well paved these may be, hunting for food in garbage boxes or dustholes. Access to buildings and to dwellings from the outside is furnished to them sometimes by defects of structure which may even be such as in every other relation are unimportant; at others through doors left open at night; but largely through the more serious gaps which occur in the course of decay of dwellings in which, also, there are sure to be many nooks in which they can permanently establish themselves. And, again, they are attracted to the neighbourhood of such dwellings especially by the lumber and organic refuse which too often are allowed by local authorities to accumulate in back yards and on waste land, and which furnish food and cover for them. The conditions adverted to are often accompanied by permanent infestation of premises with parasitical insects, among which fleas and bugs are of most importance in the present connection; for dirt, decay, darkness, and filth favour them at least as much as they favour the presence of rats. Lastly, as with other matters which fall under the general heading of care of the public health—and which comprise, it should be remembered, all matters relating to communal health or disease, from the most abstruse down to the simplest item of municipal scavenging—the dangers just indicated as conducive to epidemic plague carry others with them which are of even greater importance. Darkness, dampness, filth, and bad construction of dwellings are causes of the prevalence of consumption (for example) which annually kills more people than, it may be safely said, plague ever will destroy here during the epidemics which may occur at intervals of years. And these dangers of fostering plague, and plague especially and singularly, are by no means confined to the houses on which they actually exist. Rat-infested premises threaten the inhabitants of every dwelling in average good order which stands within a few hundred yards of them. Numbers of cases of plague occurred, no doubt, on premises which conspicuously presented some or all of the faults just mentioned; but a larger proportion occurred in the dwellings of artisans which were sometimes in good order, at others in an ordinary and fair state, and which laboured under the disadvantage of entirely insanitary methods of connection with sewers, or of the neighbourhood of ancient and dangerous sewers or drains, only within the city of Sydney.

Thus the best, and the only attainable, defence against epidemic plague lies in removal of dangerous conditions which for the most part could not occur under good municipal management, even of the elementary processes of inspection, record, and scavenging.

The

The epidemic, and the efforts to abate it by cleansing a part of the infected area, revealed to the general public the inefficiency of the work to that time done by some local authorities which, consequently, were loudly accused of neglect. Neglect there had been, no doubt; but, except in the city of Sydney, where large revenues and powers under special Acts of Parliament render excuse difficult, it has been largely unavoidable. There seems to be little ground for hope of important improvement in municipal sanitary administration until local authorities are granted power to strike a sanitary rate, from which the expenses of business-like supervision and improvement of their districts may be defrayed by them.

But funds are not all that is requisite. Knowledge and guidance are also necessary. The Public Health Act provides for appointment of Medical Officers of Health to districts, and to groups of districts. The Board carried out this instruction of the Legislature by combining the populous municipalities in the Metropolitan and Hunter River Districts, and by appointing to each combined district a Medical Officer of Health whose whole time should be devoted to his duties, the opinion having been formed by it that such officers can act efficiently only when they have no other interests. Thus the local authorities administering districts which carry rather more than a third of the total population, were furnished with competent advisers on all matters relating to the public health; for the officers referred to are officers of the combined local authorities, and are not (as they are often taken to be) officers of the central authority. But in the metropolitan district, the local authority for the city of Sydney has power, under its Act of Incorporation (1879), to appoint its own Health Officer. Without reflection on the manner in which the present and past holders of this post have done their duty, it may be pointed out that every incumbent has laboured under those very disadvantages which the Board has striven to remove in the cases just mentioned, namely, of being embarrassed by the cares of private practice, and of being entirely under direction of the Council. It is necessary that the sections of the Act of Incorporation which granted this power should be repealed, and that the city, like other metropolitan municipalities, should be transferred to the care of a medical officer the terms of whose appointment not merely ensure that he shall be skilled in the work which he undertakes, but shall also save him from all those influences which, if they came into play, would seriously impede him in doing it.

The Board, by its use of the opportunity afforded by the Public Health Act, took an important step towards establishment of a public health service on the only basis which renders sound progress possible. It is to be feared that its bearing has, so far, hardly been generally appreciated. And perhaps one reason is that, while providing for the appointment of specially-educated directorial officers, the Act stopped there, and made no provision either for giving sanitary inspectors a similar security of tenure, nor for making sure that they have had reasonable instruction in their special business before they are allowed to undertake it; nor did it co-ordinate them with the Medical Officer of Health, whose assistants and executants, under the local authority, they are. This omission should now be rectified; probably no better plan can be mentioned than that of paying half the salaries of sanitary inspectors in populous districts on condition that they are neither appointed nor discharged except with approval of the Board, which latter would have power gradually to require that every such inspector should produce some certificate or voucher for his having been through a course of instruction in the subjects of which his occupation requires knowledge. There is no doubt that local authorities would gladly accept such an arrangement, which would, besides, relieve them of some local difficulties in executing the law which they now occasionally meet with.

As soon as they are mentioned it will be perceived, doubtless, that these proposals, which were submitted on July 3rd in the form of amendments to the Public Health Act, are of a fundamental character. No efficient execution of health laws need be expected until they have been adopted; and especially no such improvement in scavenging and in buildings as can be a useful defence against incursions of rats is at all likely to be effected until, by means of the organisation sketched above, there is at least a possibility of steadily carrying out the regular inspections, keeping the registers, and causing the improvements which are required.

In special connection with the present subject certain detail amendments of the Public Health Act must be mentioned. The spread of disease by rats is a fact new to practical hygiene; but, for the future, cognisance must be taken of

of it, and special powers must be given to meet the newly recognised danger. In the first place, premises which on inspection by the proper authority furnish evidence of infestation with rats should be declared to be a nuisance liable to be dealt with summarily by addition of a definition to that effect to those which stand at commencement of the Public Health Act, Part VI. This would give magistrates power to require the owner or occupier to remove wooden floors (if any) in basements and to substitute concrete, to repair walls and effectually stop holes, to guard entrances with wire-netting, to cause doors to close thoroughly, to shield the lower parts of doors with iron plates, to remove accumulations of useless lumber from yards, and to do all other things which might seem necessary in order to prevent a recurrence of the nuisance. Secondly, power should be given to the Board to order vessels lying at wharves and quays to moor with such precautions as are best calculated to prevent free interchange between ship and shore rats, the law at present only permitting such regulations to be made under an Act which applies to public wharves alone. Thirdly, a general building Act not being in force, something of the kind should be substituted without any delay; and in the proposed amendments, already referred to, a way has been suggested by which this might probably be effected without serious difficulty. Fourthly, the law relating to management of epidemics of dangerous diseases should be so altered as to permit medical inspection or surveillance of suspected persons to be used as an alternative to detention at quarantine—namely, so as to make it possible to order persons to live at any address chosen by them, and to present themselves for examination either there or at prescribed times and places. Fifthly, local authorities should be supreme in all health matters not directly undertaken by the central health authority under the Government; their ratepayers should not be subject to the annoyance and confusion caused by liability to receive notices touching the same subject from different authorities as at present they are; but all such notices, from whomsoever emanating, should be given and enforced by the local authority alone. All of these points were also included in the amendments proposed on July 3rd, and, together with those mentioned before, have been approved by you.

It is clear that the beneficial effect of the foregoing provisions, if they were already law, could not be speedily realised. But notwithstanding the singular way in which plague is diffused, it much resembles all other epidemical diseases in this: That there is no royal road to prevention, and that safety can be attained only by steady and long-continued effort. On the other hand, the result of such efforts would tell largely towards prevention of many other diseases which afflict the dwellers in cities. The best internal defence against plague consists in good construction of dwellings and in household and municipal cleanliness, together with the slighter special precautions mentioned above. The origin of this defence lies solely in knowledge of the disease and the mode of diffusion peculiar to it; the possibility of raising it lies with the Legislature; the execution of it lies with local authorities under the Public Health Act, and can lie with no others.

I have the honor to be,
Sir,
Your obedient Servant,
J. ASHBURTON THOMPSON.

APPENDIX A.

Bacteriological Report.

By Frank Tidswell, M.B., Ch.M. (Syd.), D.P.H. (Camb.), Principal Assistant Medical Officer of the Government, Microbiologist to the Board of Health.

SYNOPSIS.

1. Initiation of Observations.

The bacteriological observations were initiated with sanious lymph obtained from the femoral gland of the first case of the series (A.P.), on January 20th, 1900, the third day of illness. The immediate microscopical examination gave every support to the suspicion of plague roused by the clinical aspects of the case, but in view of the importance of the question at issue, a final pronouncement was deferred pending the completion of the cultural and inoculation tests. The positive results obtained in both of these directions permitted the report of a definite diagnosis of plague on January 23rd, 1900, and the decision thus given received ample confirmation by subsequent observations.

The next point of evidence was secured on February 14th, when, in response to an appeal by the Department, evidence was obtained of excessive mortality amongst rats at one of the wharves in an important business section of the city. On the date mentioned seven rats, three dead and four living, were forwarded for examination, and the microscopical, cultural, and inoculation tests clearly and decisively demonstrated the existence of plague amongst the rats.

On February 24th, femoral and inguinal buboes obtained after the death of the second case in a human being (Case 2) were forwarded, and the series of tests again yielded positive results in all particulars.

From this date onwards throughout the epidemic, a period of four and a half months, practically all the time of the laboratory staff, other than that occupied in the ordinary routine of the laboratory, was taken up by plague work. The demands in this respect comprised examination of specimens from cases in human beings in which the clinical evidence admitted of doubt, or the *post-mortem* appearances were indecisive, or from hospital patients either for information with regard to some particular lesion or symptom, or as to their freedom from infection and safe discharge; examination of rats and other animals taken dead or alive at various parts of the city and suburbs; and observations on the morphology, biology, and pathogenicity of the bacilli isolated from these various sources. The data obtained in these different ways, collected and classified, form the basis of the following descriptions of the more important aspects of the bacteriology of plague.

2. Bacillus Pestis Bubonicæ.—(Figures 1–10.)

(*a*) *Morphological Characters.*

In smear preparations of material from buboes or viscera the micro-organisms were usually present in enormous numbers (v. Figs. 1, 8, 9, 10). As a general rule, the first glance revealed a field teeming with bacilli, and it was very seldom that any lengthy search was required for their detection. The individual elements were isolated, save that here and there two short bacilli were commonly seen end to end in such a position as to suggest recently-accomplished fission, whilst in preparations made from broth-cultures there were sometimes short chains of four to ten bacilli (Fig. 4). In certain specimens, especially those obtained from cases in which the severity of the illness was mild, or in which the acute stage had passed, the bacilli appeared to be enclosed within leucocytes.

Hanging-drop preparations usually showed Brownian motion. Here and there an individual element was seen to be vigorously wriggling, but no movement of translation was ever observed. No essential differences in this respect were noted between specimens taken direct from infected tissues, from young or old cultures, from liquid or solid media, or whether examined at the room temperature, or at 37 degrees C. in the Nuttall incubator. It may here be mentioned that staining methods failed to reveal the spiral flagellum described by Gordon, but it is possible that the few wriggling bacilli which may have possessed one might escape detection.

The application of Widal's method was unsuccessful with specimens taken during the early stages of illness, and blood from convalescents, whilst producing imperfect agglutination in one or two instances, was neither constant nor complete in its effect.

The bacilli stained readily with ordinary aqueous solutions of fuchsine, gentian violet, or methylene blue. They did not retain the colour when treated by Gram's method.

In stained preparations the micro-organisms usually had the appearance of a short straight bacillus, but, as a rule, there was considerable variation in the forms presented by the different elements in the same preparation (Figs. 1, 8, 9). In what may be regarded as the mature form, the outline was either that of a typical bacillus, the sides being parallel for the greater part of their length (Fig. 1), or it was whetstone

or boat-shaped, the sides being convex outwards (Figs. 6, 10). Interspersed amongst these were rounded, oval, or dumb-bell shaped elements resembling micrococci or diplococci (Figs. 1, 6, 9). The greatest mixture of forms was observed in smear preparations from infected tissues, but there was always a predominance of those above referred to as mature. In young cultures (24–48 hours) the elements were sometimes very minute, and rounded or oval in outline (Fig. 2); but the later growth was usually made up entirely of bacillary forms. As a general rule, the ends were smoothly rounded-off, but in certain preparations were more abrupt, and even irregular.

An occasional element was surrounded by a halo, which could not be demonstrated as a capsule by staining. This appearance was noted only in specimens taken directly from infected tissues. The "stickiness" of many agar-cultures was suggestive of some glutinous envelope or matrix, but nothing of the kind was to be seen in preparations from cultures, even when mounted without previous suspension of water. Spores were not detected.

The average of a number of measurements gave the bacillary forms a length of 1·8 μ, with a variation between 1·6 μ and 2·4 μ. Rarely longer forms were seen. The breadth averaged ·8 μ, and showed little variation, this feature being much more constant than the length.

In young cultures (24–36 hours) the rapidly-multiplying bacilli were sometimes smaller, but after the second or third day they attained the dimensions given above. The rounded forms had a diameter varying between ·5 and 1·0 μ.

The appearance of the unstained specimen indicated aggregation of the protoplasm at the ends of the rods. The deeper colouration of the poles after staining would thus appear to be accounted for by the structure of living bacilli, and not to result from any plasmolytic effect of the processes of drying and staining. But whilst it may be said that the majority of the specimens contained bacilli showing bipolar staining, this feature was far from being a constant character of individual elements. In some specimens it was exhibited by practically every bacillus (Figs. 6, 8, 10); in others a few elements showing it were only found after some search; in others, again, it was no more than suggested, whilst occasionally it was not at all evident. In general, bipolar staining was much more distinct in bacilli obtained directly from infected tissues than in those from cultures. The degree of colouration varied. There was rarely only a comparatively thin band at the poles with the rest of the bacillus clear; more frequently only a small clear space in the middle of the rod, which was otherwise deeply tinted throughout; but most usually the bacilli presented some intermediate condition.

As mentioned below, cultivation upon dry or salted agar readily produced crops of "involution forms" (Fig. 3). In undergoing this process some elements became greatly enlarged, reaching a length of 5 μ or 6 μ and a breadth of 1 μ, but without loss of the shape and staining properties of the original bacillus. They thus represented, so to speak, giant plague bacilli. But other elements became laterally distended as well as enlarged, forming large sausage-shaped, pear-shaped, spindle-shaped, oval, biscuit-like, circular or irregular bodies, staining with a pale uniform colour, and having no resemblance to the bacilli from which they were derived. Many of these metamorphosed bacilli contained clear round spaces (vacuoles), and if these happened to be at the edge the appearance produced was as if a bite had been taken out of them. The more characteristic involution forms have not been met with in the tissues, but the smaller circular bodies, sometimes found in considerable numbers, may, perhaps, represent them. The production of one or other of the forms above mentioned did not appear to depend upon any particular rule. The bizarre shapes were only found in young cultures; as the growth became older, the elements assumed rounded outlines, but sometimes only the latter were present from the first. The ultimate change appeared to be disintegration.

(b) Cultural Characters.

The initial cultures with material from infected tissues were usually obtained by inoculation of nutrient agar, coagulated serum, or beef bouillon. Subcultures were grown on other ordinary media (gelatine, milk, potato, &c.)

On agar tubes, inoculated with material from buboes or viscera, and incubated at 37° C., the first noticeable growth usually appeared in 36 to 48 hours, in the form of minute bright specks, very slightly raised above the surface of the medium. In the course of a day or two, the colonies became small colourless hemispheres, ranging from ·5 to 1 millimetre in diameter, then having the appearance of tiny drops of dew. Many colonies never developed beyond this stage; others extended to more or less circular patches having a diameter of 2 or 3 millimetres. When so extending, the slightly raised patch became flat on the surface, and acquired a cloudy opacity, the edges remaining thin and colourless. The cloudiness was also developed when a number of colonies became confluent. Rarely it was present from the first appearance of the colonies. A degree of opacity beyond cloudiness was not seen in growths upon agar. The maximum amount of development appeared to be reached during two weeks incubation; after that time no obvious extension of the growths was observed. When the medium was moist the colonies were apt to fuse into an expansion of irregular contour. Individual colonies were sometimes difficult to pick up, slipping about over the surface of the medium when touched by the needle. The confluent growths were often tenacious and sticky, pulling out into strings. In many instances smaller colourless and large cloudy colonies grew up side by side. The bacilli appeared to be morphologically the same in both, and although no observations were made as to their relative pathogenicity, they probably correspond to the two varieties mentioned by Yersin. In subculture the growth appeared earlier than in the original (24–48 hours), and developed as a confluent streak, raised and cloudy along the middle, but with thin, colourless, iridescent borders often having a fine corrugated appearance. The extreme border was wavy. Sometimes a row of isolated colonies formed along both sides of the streak. The breadth of the streak rarely exceeded 2 or 3 millimetres, except at the lower end, where there was often an expansion 6 or 8 millimetres wide. By rubbing or spreading out a streak, a thin, slightly-cloudy growth was obtained, which gave a ground-glass appearance when looked looked at through the thickness of the agar. With age the growth became more transparent, and often developed a mother-of-pearl iridescence.

Anaërobic cultures gave scanty growths. On agar at the room temperature, the growth was much slower, being seldom distinct in less than five or six days from the time of incubation, and reaching its maximum development in about three weeks. The appearances were very much the same, but the ultimate amount of growth less, than in cultures developing in the incubator. On perfectly dry or salted agar the growth

growth developed in very much the same way as on ordinary agar, resulting in a few days in the production of the involution forms already described. The addition of glycerine or glucose was not found to have any advantage over the simple medium. No redness was produced on slightly alkaline litmus agar, whilst the culture itself often acquired a pale-blue colour from the litmus.

On nutrient (17 per cent.) gelatine, at the room temperature the growth appeared in 3–4 days, and reached its maximum development in the course of the succeeding fortnight. In gelatine tubes, kept in the warmer atmosphere of the incubating room (16–20° C.), the colonies sometimes appeared in 24–36 hours. The general appearance of the surface culture was similar to that upon agar, but often had a white colour. In stab-cultures the growth appeared first in the form of a row of closely-placed, fine granules, which later became more or less confluent, and appeared as a well-marked whitish streak. There was a slowly-growing white expansion on the surface. No liquefaction of the gelatine occurred.

On ordinary serum tubes, inoculated with material from buboes or viscera, and incubated at 37° C., growth usually appeared in 36 to 48 hours after inoculation in the form of small, rounded, cloudy colonies. In their development the colonies reached a diameter of 2 or 3 millimetres, and acquired a creamy colour. In general, the growth was more opaque and more abundant on serum than on agar. Occasionally the serum appeared to be depressed in the neighbourhood of the growth, but there was never any observable liquefaction. In subculture the growth on serum was often visible in 24 hours.

In ordinary beef-bouillon tubes, incubated at 37° C., the growth was usually visible on the second day after incubation. As a general rule, it appeared in the form of fine crumb-like spicules attached to the sides, with more or less deposit at the bottom of the tube, the broth remaining clear and transparent. In other cases a moderate uniform turbidity was produced. No change of colour was observed in neutral litmus agar. No reaction for nitrites nor for indol was obtained, except in a few instances of growths several weeks old, in which, however, the culture appeared to be pure bacilli pestis. Growth in bouillon flasks containing oil resulted in the production of a film, scanty crops of stalactites, and a copious deposit. The number of stalactites present at any one time never exceeded six or eight; they were very fragile, and were noticed to become detached from the film and sink to the bottom of the flask with a worm-like motion. The paucity of growth of stalactites is probably attributable to the fact that the laboratory is subject to a considerable amount of vibration, sometimes marked enough to be distinctly felt, and always such as to prevent micro-photographic work in the daytime. The use of the pepto-gelatine medium of Yersin did not give results obviously better than those obtained with ordinary bouillon.

In milk the growth was much less abundant than in bouillon, and development was effected without change in the appearance of the medium.

On ordinary potato, and also on alkalinised potato, a scanty creamy growth, limited to the lower end of the line of inoculation, developed on only a few of the many tubes inoculated.

(c) *Pathogenic Characters.*

The reports of numerous investigators indicate that plague not only affects man, but is liable to attack several different species of lower animals. Rats, mice, pigs, monkeys, cats, marmots, bandicoots, and pigeons are mentioned as having acquired the disease in a natural way, whilst guinea-pigs and rabbits are the most important items of a long list of animals susceptible of infection by artificial means. In Sydney plague has been found in specimens from human beings, rats, mice, and cats forwarded for examination, and in the laboratory experimental observations have been made upon rats, mice, cats, and guinea-pigs.

The specimens from human subjects of plague comprised materials from buboes, carbuncles, blood, sputum, urine, fæces, and from the viscera in *post-mortem* cases.

The material was obtained sometimes at the initial examination by means of a sterilised syringe; and sometimes from patients in the hospital by the same procedure, or after incision when the gland had suppurated. In a few instances sloughs from buboes were examined. The results of the examinations as regards the detection of plague bacilli are shown by the following statement:—

Material taken.	Number examined.	Result positive.	Result negative.
On 2nd day of illness	1	1	...
„ 3rd „ „	5	5	...
„ 4th „ „	1	1	...
„ 6th „ „	3	3	...
„ 7th „ „	4	4	...
„ 8th „ „	4	3	1
„ 9th „ „	4	4	...
„ 10th „ „	3	1	2
„ 13th „ „	1	...	1
„ 14th „ „	3	...	3
„ 15th „ „	1	1	...
„ 16th „ „	1	1	...
„ 18th „ „	1	...	1
„ 19th „ „	1	...	1
„ 20th „ „	2	...	2
„ 21st „ „	1	1	...
„ 23rd „ „	1	...	1
„ 24th „ „	1	...	1
„ 25th „ „	2	1	1
„ 29th „ „	3	1	2
„ 32nd „ „	2	2	...
Between 38th and 94th day of illness	13	...	13
Total	58	29	29

It will be seen that plague bacilli were forthcoming in 50 per cent. of the specimens; that material taken during the first week yielded uniformly positive results, that bacilli were discoverable up to the thirty-second

thirty-second day of illness; but that at later stages, up to the ninety-fourth day, the results were uniformly negative. It may be added that pus from suppurating buboes nearly always gave negative results as regards plague bacilli; it was generally sterile, but sometimes contained micrococci.

Material from carbuncles was examined in three cases, and all gave positive results.

Material from phlyctenules was examined on two occasions, with a positive result in one case.

Blood was taken during life from thirty-two patients either from the finger or from the lobe of the ear. The results were positive in four cases, all of which ended fatally within twenty-four hours after the examination. The negative results were obtained with specimens taken at periods ranging from the second to the seventeenth day of illness.

The sputum was examined in five cases having clinical indications of pneumonia, perhaps primary in one, and secondary in four cases. Plague bacilli were detected in sputum from the possibly primary case, in which they were extremely numerous and practically pure, and in two of the secondary cases in which they were mixed with various other micro-organism.

The urine from twenty-nine patients was received into sterilised bottles, conveyed to the laboratory, centrifugalised, and the sediment examined. Micro-organisms morphologically resembling bacilli pestis were observed in ten of the twenty-nine specimens, but in no instance were they obtained by cultivation or the inoculation of guinea-pigs. In this connection it may be mentioned that no growth was observed in tubes of human urine inoculated from cultures, although other media (agar, serum, &c.) inoculated with the same material, at the same time, showed abundant development. The results were equally negative whether the urine used was sterilised by heat or by passage through the Pasteur-Chamberland filter; and whether left acid or neutralised. As well as the visible evidence, the results were tested by sub-cultivations from the urine tubes on agar or serum, which always remained sterile. But on two occasions growths were obtained from the (alkaline) urine of guinea-pigs dead after inoculation with plague bacilli.

The faeces were examined in twenty cases, microscopically and by plate cultivation, but plague bacilli were neither isolated nor seen.

Plague bacilli have been detected in specimens from various lymphatic glands, spleen, liver, lungs, and blood taken at *post-mortem* examinations on fatal cases. These specimens were submitted for examination as a matter of diagnosis, so that the results are not representative of the intra-corporeal distribution of the bacilli.

The rats forwarded for examination from various parts of the city and suburbs numbered 167. The general results are stated in the following table:—

Condition.	No.	Sick.	Putrid.	Injured.	Result positive.	Result negative.
Living	50	10	.....	3	4	46
Dead.....	117	.....	30	22	19	46
Totals	167	10	30	25	23	92

It will be seen that of the 167 rats, plague bacilli were detected in twenty-three, equal to about 12 per cent. In fifty instances the rats were alive, and 117 were dead. Of the fifty live rats, ten were sick and three injured. They were all killed and examined, with the result that plague bacilli were detected in four, all of which were sick on receipt. Of the 117 dead rats, thirty were too putrid for reliable examination, and twenty-two had injuries of such severity and character as to account for their deaths. Plague bacilli were detected in nineteen of the remaining sixty-five rats.

The pathological appearance presented by the tissues of naturally infected rats (Fig. 15 and 16) was briefly as follows:—There was usually general congestion, œdema, occasional excess of fluid in the serous cavities, and minute hæmorrhages under the skin and into various viscera. Enlargement of the lymphatic glands was a common, but not a constant feature, and when present was usually exhibited in several different situations—femoral, inguinal, brachial, lumbar. On two occasions cervical glands and on one occasion a mesenteric gland were found swollen to the size of a pea, but in all three there was great enlargement of glands elsewhere. The swollen glands were not generally discoloured, and though there were sometimes small hæmorrhages under the capsule, the periadenitic swelling and hæmorrhage characteristic of a bubo were never observed. Generally, but not always, the lungs showed patchy pneumonia, and occasionally a few hæmorrhages. The liver was usually enlarged, sometimes to as much as two or three times its normal bulk (Fig. 15), was of a lighter colour than normal, and on a few occasions was mottled with small white points. The spleen was usually swollen (Fig. 15 and 16), in some specimens it was 2 inches long and correspondingly thickened, but occasionally it was not in excess of the normal limits. The suprarenal bodies were frequently of a dark colour, and in a few instances there were small hæmorrhages under the capsule of the kidney. No definite lesions of the gastro-intestinal tract were noted. With the exception of petechial hæmorrhages under the parietal pleura and peritoneum, the remaining parts of the body presented no pathological appearances meriting special mention.

Preparations, cultures, and inoculations with material from the different viscera indicated that the plague bacilli were generally distributed throughout the bodies of the rats, but they were not always detected in the blood, nor in the lungs.

Experimental inoculation of rats was invariably successful; the animals dying after three to four days. The resulting lesions resembled those after natural infection, except that a bubo was produced in the glands corresponding to the site of inoculation.

The mice taken in different parts of the city and suburbs and forwarded for examination numbered six, and plague bacilli were detected in two of them. The pathological lesions were similar to those observed in the rat, but the small size of the organs prevented accurate observations of the finer changes. Experimental inoculation was performed on eight mice. It proved fatal in five, the deaths occurring in two and a half, two and a half, two and a half, three, four and a half days respectively. A bubo was formed

formed in all cases. The mice surviving after inoculation were observed to be very quiet, and ate sparingly between the third and sixth days after injection, but after that rapidly recovered, and became quite lively in the course of the second week. In all three instances the material used, culture or infected organs, killed guinea-pigs inoculated at the same time. In a series of three mice, the first inoculated with material from a bubo in a human patient, and the others with material from the spleen of the preceding mouse of the series, the animals died in two and a half, three, and four and a half days respectively.

Five cats were forwarded, all living, but two were sick. They were killed with chloroform. In the three apparently healthy cats no abnormalities were found on *post-mortem* examination. One of the sick cats had an angry-looking, discharging ulcer at the right angle of mouth, with inflammation of the adjacent mucous membrane extending back as far as the pillars of the fauces. The autopsy revealed general congestion of the tissues, but no œdema, nor hæmorrhages. The lymphatic glands were not enlarged. Pneumonic consolidation of lower part of right lung; other thoracic viscera normal. Spleen slightly swollen and showing numerous grey nodules; liver enlarged and mottled, section had a vague nutmeg appearance, small intestine congested, stomach and large intestine unaffected. Other viscera presented no departure from normal, except as regards congestion. Smear preparations from the ulcer showed a variety of micro-organisms, but none resembling bacilli pestis; those from the spleen contained a minute bacillus, whilst blood, lung, liver, and mesenteric gland were negative. The culture tubes remained sterile, except those inoculated from the ulcer, which gave mixed growths. A guinea-pig inoculated with a portion of the spleen remained unaffected. There was thus no evidence that this animal suffered from plague. The second sick cat was practically moribund on receipt. There was a subpectoral swelling on the left side, near the axilla, about 2 inches in diameter. This was found to have a nucleus of thin pus, surrounded by œdema. but no hæmorrhage, and involved all structures down to the ribs. In the internal organs there was general congestion, slight œdema, but no general hæmorrhages. The pleura adjacent to the pectoral abscess was intensely inflamed. Both lungs showed numerous broncho-pneumonic areas generally about the size of peas, with hæmorrhagic exudation, and sometimes necrotic central points. The bronchial glands were not visibly abnormal. The spleen was very dark in colour, but not obviously altered in other respects. No special lesions were detected in other parts of the body. Smear preparations from the subpectoral pus and œdema contained innumerable plague bacilli (Fig. 9); and preparations from the pneumonic areas were also positive; but liver, spleen, and blood were examined with negative results. Cultures from the subpectoral œdema gave abundant growths, which at subsequent dates produced fatal plague on inoculation into six guinea-pigs and two rats. No differences were observed as regards morphological, cultural, and pathogenic characters between the bacilli obtained from the cat and those derived from man or other animals.

A healthy cat was experimentally inoculated in the thigh with an emulsion of serum-culture in distilled water. Local swelling appeared in two days, with some apparent malaise. The animal was definitely ill on the fifth day, grew steadily worse during the sixth day, was comatose on the evening of the seventh day, and was found dead on the morning of the eighth day after inoculation. *Post-mortem* examination revealed hæmorrhagic exudation at the site of inoculation extending upwards to the femoral region, where a bubo existed. The corresponding inguinal and, to a less extent, the lumbar glands were congested and enlarged. There were no enlarged glands elsewhere. Beyond congestion and slight enlargement of the liver and spleen the organs showed no obvious departure from the normal. Smear preparations from the local exudation, femoral, inguinal, and lumbar glands showed innumerable plague bacilli, and though less numerous, bacilli were also plentiful in the spleen and liver. The lungs and blood gave negative results. Cultures gave vigorous growths.

Guinea-pigs inoculated in the laboratory usually died within four to five days. The exact times ranged from two to ten days, but was rarely longer than six days. No definite differences were obtained in this respect as regards the effect of material from different sources. The inoculations were generally made into the inner side of the knee. The *post-mortem* examinations (Figs. 11, 12, and 13) sometimes revealed hæmorrhagic swelling at the site of inoculation, extending up the leg, but generally there was no such local reaction. In every case there was swelling of the corresponding femoral glands, and usually also periadenitic exudation and hæmorrhage. The related inguinal were frequently, and the lumber glands sometimes, swollen, and occasionally showed periadenitic hæmorrhage (Fig. 13). In some instances other glands were were involved, *e.g.*, the deep abdominal, brachial, and cervical groups, and might even show petechial hæmorrhage, but never the appearances observed at the primary bubo. The mesenteric glands were always free from visible alteration. The tissues were generally congested, dusky, œdematous, and very commonly there were petechial hæmorrhages under the skin, serous membranes, as well as in the viscera. The lungs were rarely normal; usually they showed degrees of alteration varying from limited areas of congestion to inflammation of the greater part on both sides (Fig. 11), and petechial hæmorrhages were commonly observed in them. In some cases they were studded with miliary points (Fig. 12). The pericardium and heart rarely showed any changes beyond congestion, and sometimes hæmorrhages. The liver was usually enlarged, sometimes to twice its normal size (Fig. 11). The surface often showed discoloured areas, fine mottling of white points or numerous small hæmorrhages. The spleen was almost invariably enlarged to two or three times its normal size (Figs. 11 and 12), occasionally it was much larger. The surface was usually marked by a variable number of white spots (Figs. 11 and 12), irregularly distributed, and sometimes very numerous. The general colour was much darker than normal, either uniformly or in patches. The edges were thick and rounded. The kidneys were sometimes larger than normal, as a rule pale and marked by hæmorrhages (Fig. 13). The suprarenal bodies were generally swollen and congested, and sometimes of a deep red colour (Fig. 13). The stomach and intestines were usually unaltered in appearance, but occasionally the small intestine was congested. No definite changes were observed in the urinary organs.

The bacteriological examinations showed that occasionally the plague bacilli were practically limited to the site of inoculation and bubo, but that usually they were present in all parts of the body. They were often very abundant in the bubo, in other lymphatic glands, in the spleen, and in the liver. They were not always discoverable in the blood of the heart, even when numerous in the viscera. On two occasions they they were recovered from the urine, but were not found in the bile. Micro-organisms, morphologically resembling plague bacilli, were detected in the nasal mucus on three occasions, in all of which there was marked pneumonia.

3. Experimental Observations on the Mode of Infection in Plague.

As opportunity offered, experimental observations were made with the object of instituting comparisons with the reports of other investigators on certain epidemiological aspects of the bacteriology of plague. The work in this respect had to do with various assertions as to the manner in which plague is acquired, and more especially with regard to inoculation, ingestion, and inhalation. The results here reported represent the first fruits of a plan of investigation not yet completed in detail.

(*a*) *Inoculation.*

The experiments described in the foregoing section afford abundant testimony of the susceptibility of various animals to plague bacilli inoculated under the skin, and are in accord with the reports of authorities. It is generally believed that inoculation at some point on the external surface of the body is also the principal mode of infection in man. The significance attached to the occurrence of a bubo is that the inoculation took place through the skin of the region from which lymph is collected to pass through the affected gland. The validity of this inference is vouched for by both clinical and experimental evidence. It has occasionally happened that medical men engaged in investigations on plague have become accidentally inoculated in some particular place, and the resulting bubo has always developed in the glands associated with the part known to be the site of inoculation. Thus Dr. Sticker, a member of the German Commission sent to India to study the plague, received a scratch on the hand whilst performing an autopsy on a plague subject. This small wound was followed by enlargement and tenderness of the glands in the corresponding axilla. A similar sequence of events occurred in the cases of Drs. Aoyama and Ishigami, of the Japanese Commission, who were infected in the same way during their work at Hong Kong. Experimental inoculation of animals always results in a bubo affecting the nearest-related group of lymphatic glands. In the observations made in this laboratory, inoculation in the thigh was followed by a femoral bubo, and inoculation in the fore-leg by an axillary bubo. Hence when a bubo is present the entry of infection occurred in the corresponding part of the body, and observers have very generally endeavoured to find indications of it in the patients coming under their notice. As a matter of fact, any such evidence of the exact site of infection is rarely forthcoming. In the great majority of cases searches for such prove futile; no lesions are to be discovered. They had either disappeared by the time the examination was made, or had never existed. This has also been our experience in human beings; and in most of the inoculations on lower animals performed in the laboratory there was no local reaction at the actual point at which the bacilli were injected, all traces of the tiny wounds made being obliterated in the course of a day or two. But in many instances scratches, abrasions, or wounds of the skin have been credited with affording the means of ingress; whilst Simond and some other observers have described the occasional presence of a special local lesion, a phlyctenule, as indicative of the point of entry. Observations on both have been made in this laboratory.

(i) The Significance of Wounds of the Skin.

In a few of our cases in human beings scratches or abrasions were found which might have sufficed to admit the infection, but in all cases, when discharges or scrapings from them were examined, no plague bacilli were detected. The contamination of such wounds with plague microbes involves contact with a plague subject or with some infected inanimate material. The acquisition of plague by direct contagion has been asserted in a few instances, but the conditions under which it is said to have occurred have never been such as to place the matter beyond question. On the other hand, there is abundant evidence that even close association with the plague-stricken, as in hospitals and in most households, does not involve infection. Experimental verification of this fact has also been obtained by many investigators, and was the outcome of the following observations made upon the point in this laboratory:—

1. A healthy mouse was placed in the same jar with another mouse inoculated with material from a bubo. They remained in association during two and a half days, when the inoculated mouse died, and on *post-mortem* examination was found to be generally infected with plague. The other mouse remained perfectly healthy for a period of three weeks, and on being then killed was found to be free from disease.
2. A healthy rat was placed in the same cage with a rat inoculated from a culture. They remained in association during three days, when the inoculated rat died, and was found to be generally infected with plague. The other rat remained perfectly healthy for a fortnight, when it was inoculated from a culture of plague bacilli. It died of plague in three days.

It will be seen that in both instances animals intimately associated with others fatally sick with plague escaped infection, although in one case at least there was no insusceptibility to the disease.

In connection with this aspect of the question some experiments may be mentioned, which were designed to investigate the liability of infection being derived from the surroundings of the sick. On one occasion a mouse, on another a guinea-pig, and on six occasions rats were placed in the uncleaned jars in which animals had died of plague. In no instance did the animal so exposed become infected, although the conditions may be regarded as eminently favourable for mediate contagion. The failure to acquire the disease was not due to insusceptibility, for most of the animals subsequently succumbed to inoculation with plague-cultures or infected organs.

These experiments upon the acquisition of plague from inanimate objects raises the question of the extra-corporeal existence of bacillus pestis. The many experiments which have been performed to ascertain the behaviour of the bacilli under conditions as nearly as possible similar to those in Nature are in general accord in the conclusion that bacillus pestis is not capable of prolonged saprophytic life. As the possibility of the contamination of wounds is most likely to occur from clothing, or from dirt, some experiments on the viability of plague bacilli in such materials were made in this laboratory. The series of experiments is not yet complete, the articles hitherto used comprising only (a) silk and (b) garden soil.

(a.) Small pieces of old soft silk, 1 centimetre square, were placed in a glass double dish, sterilised, allowed to cool, and then soaked in a bouillon-culture. In the first series the excess was removed and the squares placed in the incubator at 37° for about twenty-four hours. They were then removed and kept at the room temperature; pieces being taken at intervals of a few days, and inoculated into bouillon tubes. Growths were obtained up to, but not after, the fourteenth day from the date of infection. In a second series the

sojourn

sojourn in the incubator was omitted, but otherwise the observations were made exactly as before. Again, no growth was obtained in bouillon receiving the squares of silk after the lapse of more than fourteen days from the date of infection. Thus the bacilli on the silk retained their vitality for about a fortnight only.

(b.) In the other experiments baccilli were inoculated from an agar-culture into sterilised garden mould. In some cases the dry culture was mixed with the dry mould, in others the culture was made into an emulsion with sterilised distilled water, and this added in a quantity such as to render the soil merely moist. Samples removed from the dry tubes after six and thirteen days gave no growths in bouillon. Samples removed from the moist tubes continued to give growths up to the twenty-first day. After this the soil had become drier and the subcultures showed no growths.

The two kinds of observations just described are not in themselves adequate proof of brief survival of plague bacilli in natural materials. But taken in conjunction with the results of other investigators, they suggest that the assumption of the derivation of infection from inanimate objects through wounds and abrasions can only be regarded as valid when the contact has clearly been with quite recently-infected articles.

(ii) The Significance of Phlyctenules.

The second kind of local lesion, the phlyctenule, found in plague patients, is ascribed by Simond to inoculation of plague bacilli by fleas—a conclusion at which he arrived as the result of a series of interesting observations which may here be briefly summarised. As the outcome of close inquiry into the circumstances attendant upon the well-known liability to plague infection as a consequence of handling rats dead of the disease, Simond states that a plague rat is dangerous or not, in accordance with the time that has elapsed since it died. If handled soon after death, plague may follow; but if not touched for some hours, it may then be handled without risk. It was, says Simond, just as if the infection completely evaporated within a few hours after death. He also states that perfectly healthy rats harbour very few fleas, and are very expert in removing them; but as they become sick they neglect their toilet, and fleas become more and more abundant upon them, so that they sometimes swarm upon moribund rats. After death, on cessation of the circulation, and as the body becomes cold, the fleas leave it and seek another host.

By associating the "evaporation" of the infection with the departure of the fleas, Simond inferred that these parasites were implicated in the transport of the infection. This inference was further supported by clinical observations of two kinds, viz., the site of the bubo, and the existence of a phlyctenule. Simond noticed that persons becoming plague-stricken after handling a dead rat did not necessarily develop their bubo in the axilla. As often as not in such cases the bubo was femoral. Hence the infection was not due to direct contact with the rat, but to some associated circumstance, such as invasion by fleas from the rat. It is obvious that such fleas might inflict a bite and inoculate the bacilli not on the hand or the arm, but on the leg or trunk, and thus produce a bubo elsewhere than in the axilla. He also observed that occasionally a small papule or vesicle—phlyctenule—was present on the area corresponding to the bubo; and more especially on a part where the skin was thin, *e.g.*, the dorsum of the foot. The occurrence of such a phlyctenule is vouched for by several other investigators, though not all concur in Simond's interpretation of it. This local lesion is not always apparent, and, in fact, in the majority of cases it is not to be found; but this frequent absence, Simonds contends, is due to the fact that it would only be produced when the inoculated bacilli were of comparatively mild virulence or in small quantity. Under such conditions there would ensue positive chemiotaxis, local leucocytosis and reaction; whereas, if the bacilli were very virulent, the chemiotaxis would be negative, and no such local reaction occur. Following up these observations, Simond succeeded in detecting plague bacilli in some of the phlyctenules and in fleas from plague rats, and with the latter he produced plague by inoculation of animals. He therefore concluded that if the fleas from the dead plague rat reach another rat or a human being, they may inoculate the bacilli they acquired by ingesting the blood of their former host, and so produce plague; the site of inoculation being occasionally indicated by a phlyctenule. By way of complete demonstration of his hypothesis, he showed that plague could be conveyed in the way suggested. He placed in a large glass jar a sick rat, and also a healthy animal (rat or mouse), the latter being enclosed in a small cage so as to prevent contact with the sick rat. If he left or placed fleas upon the sick rat, and allowed its body to remain lying in the jar for some hours after death, the healthy animal sometimes developed plague and died; but if he previously removed all the fleas from the rat and repeated the experiment otherwise precisely as before, the healthy animal did not die, but remained perfectly well.

Simond's observations and experiments were repeated in this laboratory as opportunity offered. As already mentioned, phlyctenules were found in six patients, and smear preparations were obtained from two of them. The examination of the preparations from one proved negative, but those from the other showed a small number of micro-organisms having the morphological characters of plague bacilli. As no further tests were possible, the exact nature of the bacilli remained unascertained. It may here be mentioned that a lesion resembling a phlyctenule was artificially produced in one of the experimental animals. A guinea-pig was inoculated in a small, shaved, sterilised area on the fore-leg, by being pricked with a needle previously sterilised, cooled, and then dipped in a plague-culture. On the following day a small inflamed papule had developed at the site of inoculation, and on the third day, when the animal died, this papule showed a whitish spot at its apex as though about to undergo vesiculation. *Post-mortem* examination revealed the general appearances of plague, including an axillary bubo, and plague bacilli were found in the papule, bubo, liver, and spleen. The production of the phlyctenule in this case corresponds with Simond's hypothesis, inasmuch as the number of bacilli inserted by the process adopted was very much less than in inoculation performed in the usual way, which is not followed by any such lesion.

Examinations were made of fleas from healthy human beings, from a plague patient, from mice, from rats, and from cats. The microscopical examinations all prove negative except in the case of fleas obtained from a rat actually sick with plague. This rat was taken in a house from which a case of plague had been removed five days previously, and in the vicinity of which many persons were attacked. The animal was killed with chloroform, and about a dozen apparently stupefied fleas were obtained from its body. The fleas were crushed up in a few drops of sterilised distilled water, and as preparations from the emulsion so obtained showed micro-organisms resembling plague bacilli (Fig. 5), the remainder of it was inoculated into a guinea-pig. The animal became sick, and died on the seventh day. The *post-mortem* appearances were those of plague, and micro-organisms resembling bacilli pestis were found in the bubo, in the blood of the heart, in the spleen, and in the liver.

In

In the experiments performed with living fleas, the conditions described by Simond were slightly modified. A rat, selected because of its having many fleas upon it, was inoculated with plague bacilli from a culture and placed in a small wire cage. A second healthy rat was placed in a similar wire cage. The two cages containing the rats were both placed in the same (sheet iron) larger cage, the interval between them being about 2 inches. The inoculated rat died in three days, and its dead body was allowed to remain in the cage for twenty-four hours. It was then removed, and on examination was found to be generally infected with plague. The other rat remained perfectly well for a period of four weeks. The experiment was repeated under exactly the same conditions, except that numerous fleas, obtained by the chance discovery of a mouse's nest, were thrown into the cage, and upon the inoculated rat. This animal also died in three days, its body left twenty-four hours in the cage, and when examined found to be generally infected with plague. A third rat was placed in the uncleaned cage. Neither the first nor the third rat became infected.

It will be seen that the observations we had the opportunity of making in this laboratory gave support to Simond's assertions, as regards the presence of plague bacilli in phlyctenules and in fleas from plague rats, and, whilst the results in the experiments with living fleas were negative, it has to be noted that such tests are obviously liable to miscarry owing to the several uncontrollable factors involved in their performance.

(*b*) *Ingestion.*

Authorities are not agreed upon the question of the acquisition of plague by ingestion of infected diet. In the epidemic at Hong Kong in 1894, plague was said to sometimes take a special form indicating that the infection had entered through the stomach or intestines. This form is said not to have been observed in India, and *post-mortem* examinations have generally failed to reveal evidence of gastro-intestinal infection. No sign of intestinal plague was observed in our own cases. Experimentalists are also at variance—some having succeeded, others having failed, to infect animals by feeding. In this laboratory ingestion experiments were performed by feeding animals with bread, or biscuit, sopped in a bouillon-culture, or in an emulsion of agar-culture; and by the contamination of carrots or bread with, or, in the case of rats, actual feeding upon infected organs. The result of the eleven experiments of this series are shown in the following tabular statement :—

No.	Animal.	Experiment.	Result.
1	Guinea-pig	Fed with bread; infected from agar-culture	Unaffected.
2	„	„ „ bouillon-culture ...	„
3	„	„ infected liver.....	Died in 5½ days.
4	„	„ „	Unaffected.
5	Mouse	„ biscuit, sopped in bouillon-culture.....	„
6	Rat	„ bread infected from agar-culture	„
7	„	„ biscuit infected from bouillon-culture ...	„
8	„	„ liver and sternum of infected rat	Died in 6½ days.
9	„	„ „ „ „	„ 10½ „
10	„	„ „ spleen „	„ 4½ „
11	„	„ „ „ „	„ 4½ „

The various animals received the infected food on one occasion only, and in all cases a control animal, inoculated with the same material, died in the usual time. It will be seen that whilst feeding with cultures was always unsuccessful, a diet of infected organs proved fatal in one of two guinea-pigs, and in all from rats fed upon it. In the fatal cases there were no signs of external injury such as might result from scratching with infected claws, and no bubo indicating that inoculation had occurred in any such way. Further, in most instances the animals were kept in cages by themselves, so as to prevent fighting, &c., by which inoculation might also be effected. The fact of plague infection was verified by *post-mortem* and bacteriological examinations. The guinea-pig and two of the rats which died showed no gastro-intestinal lesion beyond congestion of the iliac portion of the small intestine, and even this was absent in a third rat. The mesenteric glands were not enlarged in these cases. But in the fourth rat there were well-marked indications of the passage of the infection through the walls of the digestive tract. The stomach and intestines showed fine hæmorrhages, and the ilium and first part of the large intestine were intensely inflamed. Connected with the stomach there was a large deeply-congested lymphatic gland. The blood-vessels in the mesentery were engorged with blood, and the mesenteric lymphatic glands were swollen and fused into a sausage-shaped mass. The cæcal end of the large intestine was involved in hæmorrhagic fibrinous exudation, causing adhesions, and extending into the swollen mesenteric glands. These various changes are shown in Figure 14.

From the results of these experiments, the provisional conclusion is drawn that animals may become infected by ingestion of infected materials. The susceptibility would appear to vary in different animals, rats being more liable to acquire infection in this way than the other species tested. It would seem also that something depends on the exact condition (virulence?) of the plague bacilli with which the food is contaminated.

(*c*) *Inhalation.*

Infection by inhalation is stated to be responsible for plague pneumonia, a fatal form of the disease of which we have fortunately had practically no experience. As in the case of ingestion, so with inhalation experiments, observers have sometimes succeeded, sometimes failed, to infect animals. In this laboratory the only experiments made in connection with this aspect of plague-infection were repetitions of those of Batzaroff, who produced pest-pneumonia by deposition of culture material on the uninjured nasal mucous membrane of rabbits and guinea-pigs, and by smearing the nostrils of rats and mice. The material used by us included culture material, and fresh plague-infected organs, but in five experiments performed the results were always negative.

APPENDIX B.

The Clinical Aspects of Bubonic Plague, as observed in the outbreak of the disease in Sydney during the period commencing 20th January and ending 9th August.

By A. E. Salter, M.B., Ch.M., Melb., in charge of the Isolation Hospital.

During that time, as the subject matter of the report which precedes this has shown, there were 303 cases of this disease reported at the office of the Department of Public Health for New South Wales.

Of these 303 cases, 10 were among persons of the Chinese race, and the remaining 293 among persons of European descent; of the 293 Europeans, 13 had become affected with the disease at some time subsequent to their inoculation with Haffkine's serum.

In order that a comparison may be instituted between persons of the same race only, these 10 Chinese have been kept in a separate group by themselves.

The 293 Europeans have been divided into four groups—the first three according to centuries—the first of these contains the first 100 Europeans reported suffering from Bubonic Plague, the second group contains the second 100 reported, the third contains the 93 remaining after the first 200 have been dealt with, the fourth being made from Haffkine's inoculated cases, which have been picked out from the different groups in which they are scattered and placed in Table 2, in order that the prodromal symptoms with which they were attacked may be compared with the prodromal symptoms of the complete group. Thus we have a total of five groups, which for convenience of reference have been called by the letters A for the first 100 European cases, B for the second 100, C for the remaining 93 Europeans, D for the inoculated persons, and E for the 10 Chinese.

Comparing the first three Groups A, B, C, of the series, to learn when they came under the notice of this Department, it is found that Group A was reported between the 20th January and the 12th April, in fact that these 100 cases developed in a period of 82 days. Group B came to light in 28 days, so that the second 100 cases were produced in slightly more than one-third the time that it took to produce the first 100. The cases of Group C were discovered between 9th May and 9th August, that is in 93 days, or in a period more than three times as long as it took to produce the cases comprising Group B.

As there is this difference between the periods of time taken to produce these three groups, it might be inferred that the virulence of the infection accrued during the first period, reached its zenith in the second, and declined during the third. Yet the death rate among the cases in Group A was 37 per cent., while it was 37 per cent. among the cases in Group B, and 22·6 per cent. among the cases in Group C, which seem to point, if not to a greater virulence in the first portion, to at least an equal virulence, and a study of the incidence of nervous symptoms tends to strengthen the latter inference. Taking a mean of all the temperatures recorded, when the case has been seen for the first time, the mean for Group A is 103·2, the mean for Group B is 102·8, and for Group C it is 102·1, showing that there was a gradual ebb in the temperature wave. Whatever be its cause, the first 100 cases of Bubonic Plague occurred at the rate of 1·2 per day, the second 100 at the rate of 3·5, and the third at the rate of 1 per day. The premonitory symptoms most frequently complained of in each group have been taken out and put into Table 1, and the number of deaths in each set of symptoms has been put down with the object of showing what mode of attack may be regarded most gravely, and therefrom to form a basis for prognosis in the earlier stages from the initial symptoms.

Group A.

From Table 1 it appears that pains in the body, back, and chest were complained of as initial symptons in 23 cases; of these 23 eleven died giving a mortality of 47·8 per cent. Vomiting, not the commonest premonitory symptom, had the second greatest percentage of deaths among those who suffered from it. It was a premonitory symptom in 55 cases, and of the 37 persons who made up the total number of deaths in Group A 26 suffered from this initial symptom so that 47·3 per cent. of the persons affected with vomiting died. Headache was complained of in 72 cases, of them 26 died, giving a percentage of 36, while symptoms referable to the lymphatic glandular system were complained of at the very onset of the attack in 29 cases with 11 deaths. The percentage of deaths among cases presenting this symptom was 37·9.

For purposes of prognosis in Group A pains in the body, back, and chest were most important, vomiting being almost equal. The mean average of all the first recorded temperatures was 103·2.

Buboes.—The lymphatic glandular system was affected in the cases of this group 97 times, while in the remaining 3 no abnormalities were discovered nor referred to by the patient.

From Table 4 it appears that the most frequently affected glands were the right femorals, the next in order being the left femorals, while those next in order were the inguinals, but far behind the two first. The femoro-inguinal regions were responsible for a total of 83 cases, leaving 14 to be divided among all the others when the mortality among these cases is considered it is found that in the 3 cases with no glands there were 3 deaths, and among the 30 cases of right femoral, that there were 10 deaths, among the 25 cases of left femoral that there were 7 deaths. The femoro-inguinal regions with 83 cases were responsible for 25 deaths, while among the remaining glandular regions there were 9 deaths; so that the 14 cases of Bubonic Plague in which the sub-pectoral, axillary, or cervical glands were affected were responsible for 9 deaths showing a percentage of 64·2. The preponderance of mortality was much greater in cases with glandular troubles of the cervico-axillary regions. In 46 cases the buboes were incised. Of these 46 there were 3 operated upon which died subsequently, therefore, 43 of the incised cases recovered and 34 of the deaths took place prior to the suppurative stage being reached, leaving 20 cases in which recovery took place and the buboes resolved, so that of the 63 persons altogether who survived, 68 per cent. suffered from suppuration of their enlarged glands and 30 per cent. recovered with resolution of their glandular affections. Pain or tenderness of the glands at some period of the illness, not necessarily at first—was complained of 57 times altogether.

Secondary Buboes.—These occurred 7 times, but by the expression secondary buboes is meant those buboes occurring after a well-defined term had elapsed between the appearance of the first bubo or chain of buboes, because it was not always easy to determine the order of precedence where several buboes arose in the illness.

Nervous Symptoms (*see* Table 3.)—Symptoms referable to derangement of the nervous system, such as trismus, delirium, coma, semi-coma, staggering gait, thickness of speech, convulsions, screaming, occurred either singly or in combination with each other in 72 cases. Of these 72, there died 28, or a

percentage

percentage of 38·9 Taking these symptoms separately, coma was seen 4 times, semi-coma 25 times, delirium (ordinary) 33 times, delirium (furious) 17 times, getting out of bed 9 times, hebetude 12 times, speech was affected 23 times, staggering gait is recorded as occurring twice, screaming of a wild and furious nature twice, convulsions 6 times, trismus twice, insomnia 7 times. Spitting: This curious habit occurred in 5 cases; it consisted of a desire to expectorate, though there was no mucous which could be regarded as obnoxious, as far as its appearance afforded opportunity for judgment. The cases which exhibited this symptom would sometimes expectorate right across a ward. If addressed upon the subject they continued their habit, taking no notice of remonstrances, and not trying to avoid any object which might be in the line of fire. Among these 5 there were 3 deaths. It was always regarded as a grave symptom, and in the 2 cases in this group which exhibited it, yet recovered, the train of the symptoms was as follows:—In the first, temperature 104·6, with furious delirium, clammy perspiration, pains in the muscles, irregular pulse, respirations with a frequency of 30 and in the second temperature 103·8, ordinary delirium, pulse very soft 124, respirations 38 and insomnia.

Organs of Vision.—The conjunctivæ were deeply injected in 7 cases; the ultimate result of this injection was as follows:—In two cases considerable mischief to the eyeball took place, the sight of the right eye being quite lost in the one, and considerable corneal impairment supervening in the other. In 3 cases it gradually dispersed, no lesion of the eye taking place; in the other two, though iritis and ulceration of the cornea took place, both recovered and left the Quarantine hospital without any apparent mischief being left behind.

Eruptions of the Skin.—Ecchymotic patches were seen in 6 cases, Erythematous eruptions 3 times, Petechial eruptions twice, Miliary eruptions 3 times, Scarlatiniform once, Eczematous once.

Tongue.—This organ presented the character of being covered with a creamy white fur on the dorsum, and having the tip and edges bright pink and clean in 43 cases.

Septicaemic Cases.—Those 3 cases, with no glandular lesions discoverable during life, died and were not admitted to hospital. The course of their illness in two cases was 30 hours; the third had been ill several days at notification. These may be regarded as Septicaemic cases.

GROUP B.

The premonitory symptoms of this group are found by reference to table 1 to have been, as in the former group, headache, vomiting, rigours, symptoms referable to the lymphatic glandular system, pain in the back, body, and chest, in the order named as far as frequency is concerned. When the mortality in each set of symptoms is considered, the cases of vomiting are accredited with 40·4 per cent. of deaths, the cases of pains in the body, back, &c., with 36·6 per cent., headache with 31·2 per cent., rigors with 34 per cent., and symptoms referable to the glandular system with 25·6 per cent. For purposes of prognosis in these cases, the vomiting stands the highest in the rate of mortality, pains in the back or body coming next. The mean average of all the temperatures first recorded is 102·8.

Buboes.—The lymphatic glands in this group were affected in 93 cases, and in 7 cases no glandular troubles could be discovered. The left femoral glands were affected alone 21 times, the right femoral alone 16 times. The right inguinal were affected 10 times, and the left inguinal 5 times. Taking inguinal and femoral for both sides together, we find the right groin affected 32 times, and the left groin affected 31 times. To get the femoro-inguinal chain complete there should be added the 4 cases in which both groins were affected in the one individual, and the one case in which the right femoral and left popliteal were affected. The total in this chain for Group B is, therefore, 68. It appears from these observations, and from the observations in Group A, that the femoro-inguinal chains on both sides had about equal chances of infection, and were very much more often affected than the other regions. It must be remembered that the glands of the groin were also frequently affected at the same time as were those of the region next to be considered.

The Axillary Region.—The axillary glands were affected unilaterally once for each side—the cervical glands of the right side once, and of the left side 3 times, in each case unilaterally; but axillary and cervical glands (not considering those just mentioned) were, in combination with some other of the lymphatics, affected 17 times. There were also 1 right and 1 left subpectoral, which are included in the axillary chain. On adding all these together, it appears that the cervico-axillary chain was affected 25 times. The mortality in these two divisions was 19 for the femoro-inguinal chain and 12 for the cervico-axillary chain, being a percentage of 26·4 in the first case and 48 in the second. The most fatal kind were the cervical, as in the 4 cases where the cervical alone were affected 3 died, or 75 per cent. Incision was necessary in the glands of this group in 41 cases. Of the 41 buboes incised there were 2 among them in which death supervened, leaving 39 cases operated upon with recovery, and 34 cases of death without the stage for operation being reached, and 25 in which there was recovery without incision. Taking the cases, therefore, of recovery, viz., 63 in all, it appears that the percentage of them which needed operation was 62, or somewhat less than the percentage needing operation in Group A, while the percentage of cases recovering in which the glandular structures did not break down at all was 39.

Secondary buboes occurred in 17 cases.

Nervous symptoms (*see* Table 3). Symptoms indicating derangement of the nervous system occurred either singly or in combination with each other in 62 cases; of these 26 died, giving a percentage of 42 deaths. Separately they occurred as follows:—Coma, 9 times; semi-coma (not counting it when it went on to coma), 8 times; delirium of an ordinary kind (not counting it when it became furious), 33 times; furious delirium, 15 times; getting out of bed, 18 times; mental hebetude, 6 times; wild delirious screaming, once; convulsions, twice; affection of the speech was noted in 15 cases; insomnia was complained of 5 times; and staggering gait noticed 5 times; spitting occurred in 4 cases, with 3 deaths.

The Organs of Vision.—In this group 4 persons suffered from a deep injection of the conjunctivæ, with the final result that in the case of 1 bilateral iritis, hypopyon and panophthalmitis supervened, with complete blindness. One case cleared up when in hospital, but on returning to work the left eye was found to be weak, and to have a tendency to a recurrence of the injection. The third cleared up completely, and the eyes were strong and well when last heard of. The last of these 4 died before the eyeball became affected.

Eruptions of the Skin.—Erythema occurred 4 times, ecchymoses 4 times, and petechiæ 4 times. In 1 case the body became purple all over sometime before death; in another varicella was just disappearing as bubonic plague came on. Epistaxis occurred in 1 case in this group important enough to require special notice (Case 183).

Septicæmic Cases.—There were 7 cases without glandular symptoms. Of these, 2 were admitted to hospital, the other 5 died too soon in their progress of their illness to admit of removal; of those 2 who were admitted, 1 recovered; the other, after lingering some days, finally succumbed.

GROUP C.

GROUP C.

As in the previous groups, the same premonitory symptoms were recorded. Forty-nine cases complained of vomiting, and 14 died; 49 also complained of headache, of them 10 died. Pains in the back, etc., were complained of only 13 times, with 3 deaths; rigors occurred in 62 cases, with 14 deaths. Symptoms referable to the glandular system are noted in 34 cases, with 5 deaths. Even when allowance is made for the fact that in this group only 93 cases are under consideration as against 100 in the two previous groups, it would appear that the number of persons complaining of pains in the back and bones had very markedly decreased. The mean average of the first noted temperatures was found to be 102·1.

Buboes.—The inguino-femoral chain in this group produced 58 of the total of 89 cases in which buboes were found, the remaining 31 being divided thus: Axillary and subpectoral regions furnished 16, cervical 4, and the cervico-axillary region combined with some other region, or with each other, furnished 11. There were 4 cases without any buboes, which brings the total up to 93. The mortality as shown in Table 4 points to the same preponderance in the same regions as was noticed in the other groups, the axillary and subpectoral chain being most fatal, with 50 per cent.; the cervical being the next in order, with 25 per cent., until the inguino-femoral chain is reached with 12 per cent. Thirty buboes were incised. Of these 30 incised cases 1 died, and 43 recovered without incision, the buboes resolving. Thus 40 per cent. of the cases recovering needed operation. There were 20 deaths in which no incision was justified. The percentage of cases recovering with resolution was 59·7.

Nervous Symptoms.—Symptoms referable to derangements of the nervous system: Coma occurred in 3 cases, with 3 deaths; semi-coma (not going into coma) in 3 cases, with 2 deaths; delirium (ordinary) in 18 cases, with 7 deaths; delirium (furious) in 6 cases, with 3 deaths; getting out of bed in 7 cases, with 2 deaths; hebetude is noted once, with no deaths; affection of speech in 12 cases, with 2 deaths; insomnia in 3 cases, with 2 deaths; loud screaming in 3 cases, with 1 death; convulsions in 1 case, with 1 death; staggering gait in 2 cases, with 2 deaths. One or more of the foregoing occurred either singly or in combination with each other in 39 cases, or in 42 per cent. of the total admissions. Of these 39 there died 16, being 41 per cent. of deaths. Spitting was observed in 1 case, which was fatal.

Organs of Vision.—The conjunctivæ were deeply injected in 5 cases with following result:—That in 1 case there was some iritis going on to hypopyon, which cleared up the eye, recovering finally, though very weak. Of the other 4 cases, 1 died too early in his illness to show what the future held in store for his eyes, while the remaining 3 never became more than merely conjunctiva injection; finally they cleared up altogether. Eruptions of the skin in this group were: Eczema, once; urticaria, several times; erythema, once; petechia, once; large ecchymosed patches came out in 1 case a short time before death.

Septicæmic Cases.—There were 4 cases in which no glandular symptoms were distinguishable during life. Of these, 2 were admitted to hospital, and 2 were overcome before it was possible to remove them. Of the 2 who were removed to hospital, 1 recovered; the other, after an illness of 9 days, died.

GROUP D.

This group comprises the cases inoculated with Haffkine's prophylactic. They are placed in Table 2 to show how their premonitory symptoms compare with those of the cases in Table 1, where the whole list of cases in each group is dealt with. It is worthy of note that on comparing these two tables it appears that the inoculated cases had milder prodromal symptoms. These persons suffered from vomiting as an initial symptom only 4 times out of the 13, and from pains in the back and body only once. Their glandular regions were affected as follows:—

Swelling of the right femoral occurred 4 times, of them 1 was incised; left femoral 4 times, of them 3 were incised; right inguinal once it was incised; left inguinal twice, 1 was incised; right inguinal and femoral once it was incised; right and left femoral once, and was not incised; right cervical once, and was not incised. Thus of these 14 buboes, 7 were incised, the remainder resolved. As strengthening this comparison, it is to be borne in mind that Table 1 has the advantage of having the inoculated cases included in it, so that it gets the benefit of their less-marked symptoms.

GROUP E.

Chinese.—There is not much to be said of this group, because of the 10 persons who were attacked 7 were discovered in extremis. Those whose faculties were not completely clouded by the intoxication of their disease were unable to speak English well, and could not give much information. Two out of 10 recovered, and of them 1 suffered the loss of an eye as a result of the injection of the conjunctivæ followed by iritis and panophthalmitis. Both eyes were affected with iritis, but in the 1 case it cleared away, and good vision has remained in this eye, while total loss of vision resulted in the other. The buboes recorded were 1 right inguinal, 1 right inguinal and femoral, 1 right and left inguinal, 1 left axillary, 1 left cervical, 1 right and left cervical, 1 right femoral. Three had no buboes, as far as can be ascertained. That case with the right inguinal and femoral gland affected, and that case with the right femoral affected, are the 2 which recovered. In both cases the buboes were incised. In 1 of the Chinese a carbuncle formed on the right hip. He recovered. Of the 10 who were attacked, 5 were admitted to hospital, the other 5 died before they could be removed. Of the 5 admitted to hospital, 2 recovered, the remainder died.

Taking all the cases together, reference must be made to a symptom exhibited by a few cases, and not referred to in the detailed account, viz., swelling of the legs, especially of the thigh. The swelling was not odematous. No glands were perceptible to the touch, and there was no tenderness in any of the glandular regions.

This occurred only occasionally during the acute febrile stage of the disease, and in some cases death supervened, in others recovery.

That swollen condition frequently seen during and after convalescence is not the swelling now referred to. This last was fairly frequent, and was doubtless caused by the impediment to the return circulation resulting from a healing bubo.

The first took place when there had been no apparent bubo.

Hæmorrhages.—Those hæmorrhagic effusions occurring under the skin in cases of bubonic plague have been dealt with in the various groups under the heading of eruptions of the skin.

Under the present heading the symptom referred to is an unnatural discharge of blood, sufficient in quantity either to threaten the life of the patient, or being poured into some important organ to cause the destruction of that organ.

Although

Although hæmorrhage from the lungs, in the form of hæmoptysis, occurred in about half of the cases in which the secondary cause of death is set down as apnœa, that form of hæmorrhage is not meant here. It never occurred in sufficient quantity to endanger life.

Epistaxis.—This was not at all frequent, even in a mild form, although it was seen occasionally. I had no bearing on the cases, and did not happen in the earlier course of the fever, excepting in one case. This was one of those cases in which the hæmorrhage was excessive enough to be a source of danger to the patient. It was stopped only with difficulty, and later on death supervened, and appeared to have been accelerated by the loss of blood. Hæmorrhage from the stomach occurred twice in such large volume that it caused the collapse of the patient. It came on suddenly, and lasted for but a few minutes, very large quantities of dark red blood being ejected.

The patients admitted to Quarantine hospital were suffering from an acute febrile disease, having prevailing characteristics distinguishing them from the ordinary run of febrile diseases met with in general practise.

Those characteristics were most commonly some affection of the lymphatic glands, such as swelling, pain, or tenderness referable to one or more of the glandular regions. Considerable mental disturbance usually appearing in the form of drowsiness and a general appearance of being very ill without any cause being found. These indications were accompanied by marked disturbance in the circulation, concerning which nothing has been said in the detailed report of the symptoms. The pulse, in all cases where it was evident from other indications that the person under consideration was very ill, had characters which were in sympathy with the general condition; it was usually accelerated and compressible; sometimes dicrotic, sometimes intermittent; and was always watched with the greatest care.

In cases where the illness was prolonged past the stage of acute plague, the pulse would often be found accelerated, and as many as 120 or 130 beats to the minute without any marked rise in temperature. This acceleration was not reduced by the exhibition of such drugs as digitalis and strophanthus, although given in large continuous doses. It seemed that where the disease left the pulse with those characteristics it gradually returned to its natural condition of its own accord. The respirations were accelerated not, however, on account of any mischief being present in the structure of the lung itself, but irrespective of lung complications, and in cases that were about to end fatally that increase would gradually continue until as many as fifty per minute would be recorded. During the month of May and thereafter the character of the symptoms, as shown by the cases on their admission to the Quarantine hospital, changed. It was conjectured from the alteration in the type of the cases received that the outbreak was coming to a conclusion. Cases were admitted but seldom in which unconsciousness was present. Usually the cases showed very little indications of being very ill. Either some fever or glandular trouble was present, generally there were both, but other constitutional symptoms were less frequent. Not only was the mean average temperature lower, but there was a diminution in frequency in the derangement of the nervous system. This is evidenced by the fact that the records of the cases show that the frequency of certain nervous symptoms, either alone or combined, was in Group A, 72 per cent.; in Group B, 62 per cent.; but was in the cases of the last ninety-three only 42 per cent. (*see* Table 3). This marked alteration was not due to any particular method of treatment adopted; it was due to the difference in the type of the cases. The 72 or 62 or 42 per cent. of the persons who suffered from the nervous symptoms detailed did so from the time of their admission to Quarantine; patients were, in the early part of the outbreak, for the most part in a drowsy or semi-conscious state when admitted. In the latter part of the outbreak these symptoms were conspicuously absent in the patients when admitted. Indeed, no such thing as a case entering Quarantine with mild symptoms, and getting worse or dying, ever happened. The first 200 cases were, with some exceptions, either delirious or drowsy or in a comatose state when they were received, but more than half the latter cases were quite conscious, mentally clear, and not inclined to believe that they were seriously ill, nor did they turn out to be so. Probably the source whence the infection was being received was no longer producing such virulent material, but whatever be the reason it is certain that the type of the disease was becoming modified.

Cause of Death.—In considering the secondary cause of death, only those cases which were admitted to Quarantine and died there are referred to.

The number of these is 64, leaving 39 who died elsewhere, the end having come either too quickly to permit of their removal, or else, as no doubt happened in the case of some of the Chinese, the fact of the individual's illness did not become known until he was in a moribund condition, or perhaps actually dead.

The secondary cause of death is as follows:—

Cardiac failure.—Failure of the central organ of circulation was the secondary cause of death in 26 cases—that is to say, the heart gradually grew weaker and weaker until death supervened.

Apnœa—In 24 cases the patients were really asphyxiated. There was a collection of thin mucous in the trachea and bronchi; sometimes there was hæmoptysis. Abnormal chest sounds were not always discernible.

The condition seemed to be as if the mucous membrane of the bronchi was affected similarly to the mucous membrane of the eye, and by the same irritant. (The same irritant no doubt was at work on the mucous membrane of the fauces in the cases where spitting was a prominent symptom.)

Exhaustion.—In 5 cases the patients, having got through the acute stage of plague, seemed unable to recover their vitality. The digestive organs did not act, or there was continuous vomiting, or the rate of the pulse, as has already been stated, became very high, and did not respond to the drugs which were exhibited. The nervous system seemed to have received permanent injury, and they died ultimately of exhaustion, after an illness of from thirteen to ninety-eight days.

Convulsions.—These were the secondary cause of death in 6 cases, and of them there was a previous history of convulsions in one case only; but, probably, if the facts could have been traced, it would have been found that a family history of convulsions existed in the majority.

Hæmorrhage.—Hæmorrhage from the stomach (already mentioned among the hæmorrhages) was so profuse as to terminate life suddenly in 2 cases.

Coma.—In 1 case the patient was in a profound coma, and continued so until death, being in that condition a little over two days.

TABLE 1 showing the number of times the symptoms mentioned occurred as the earliest observed symptoms of illness in 293 whites, divided into three arbitrary groups containing—in Group A, 100 cases, 20th January to 12th April; in Group B, 100 cases, 12th April to 9th May; and in Group C, 93 cases, 9th May to 9th August;—together with the number of Deaths which occurred among patients having the symptoms as specified.

Symptoms occuring at the onset of illness.	Group A.			Group B.			Group C.			Totals.		
	No. of Cases in which the Symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths.	No. of Cases in which the Symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths	No. of Cases in which the symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths.	No. of Cases in which the symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths.
Vomiting	55	26	47·3	57	23	40·4	49	14	28·5	161	63	39·1
Pains in the back, body and chest bones.	23	11	47·8	30	11	36·6	13	3	23·	66	25	37·9
Headache	72	26	36·	64	20	31·2	49	10	20·4	185	56	30·3
Rigors	32	10	31·2	50	17	34·	62	14	22·5	144	41	28·5
Symptoms referable to the Lymphatic Glandular System, as pain or swelling.	29	11	37·9	43	11	25·6	34	5	14·7	106	27	25·5

TABLE 2 showing the number of times the symptoms mentioned occurred as the earliest observed symptoms of illness in thirteen patients who had been inoculated with Haffkine's prophylactic, at dates before attack, which varied between one day and thirteen weeks, for comparison with Table 1, in which they are also included.

Consecutive No. of Case	36	37	41	42	44	47	51	57	66	103	115	214	285	Total.
Vomiting	...	...	...	•	...	...	...	...	...	•	•	•	...	4
Pains in Back, Body, &c.	...	...	...	...	...	...	...	...	...	•	...	...	...	1
Headache	•	•	•	•	•	•	•	•	...	...	•	•	•	11
Rigors	...	...	...	...	...	...	...	...	...	•	...	•	•	3
Symptoms referable to the Lympathic Glandular System, as pain or swelling.	•	...	...	•	•	•	•	•	•	...	•	•	•	10

All the patients referred to in Table 2 recovered.

TABLE 3 showing the number of times that one or more of the following symptoms, indicating derangement of the Nervous System, were observed in the patients constituting each of the three Groups at admission to hospital, and the percentage of the total number in each Group who were affected thereby.

Symptom.	Group A (First 100 Whites).				Group B (Second 100 Whites).				Group C (Remaining 93 Whites).				Totals.				
	No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.	Percentage of Deaths.		
Coma	4	3			9	3			3	3			16	9	56·2		
Semi-coma (not ending in Coma)	25	17			8	2			3	2			36	21	58·3		
Delirium (ordinary)	33	12			33	10			18	7			84	29	34·5		
,, (furious)	17	8			15	10			6	3			38	21	55·3		
Getting out of bed	9	6			18	13			7	2			34	21	61·8		
Hebetude	12	6			6	...			1	.....			19	6	31·6		
Affections of speech	23	11			15	8			12	2			50	21	42·0		
,, gait	2	1			5	2			2	2			9	5	55·5		
Trismus	2	1			...	.....			...	.....			2	1	50·0		
Furious screaming	2	.....			1	1			3	1			6	2	33·3		
Convulsions	6	4			2	2			1	1			9	7	77·7		
Insomnia	7	.....			5	3			3	2			15	5	33·3		
			Total number of cases in this group in which one or more of the foregoing symptoms were observed = 72 (or 72 per cent.)	Percentage of deaths among the above = 38·9 per cent.			Total number of cases in this group in which one or more of the foregoing symptoms were observed = 62 (or 62 per cent.)	Percentage of deaths among the above = 42 per cent.			Total number of cases in this group in which one or more of the foregoing symptoms were observed = 39 (or 42 per cent.)	Percentage of deaths among the above = 41 per cent.			Total number of cases in which one or more of the foregoing symptoms were observed = 173 (or 59 per cent. of total number of patients).	Percentage of deaths among the above = 40·5 per cent.

TABLE 4.—Showing in what proportion of Cases Buboes occurred, and the several regions of the body in which they occurred, together with the mortality which followed on affection of each region.

	Regional Buboes.	Group A. (First 100 Whites.) No. of Cases in which Symptoms mentioned occurred.	Group A. (First 100 Whites.) No. of Deaths among foregoing.	Group B. (Second 100 Whites.) No. of Cases in which Symptoms mentioned occurred.	Group B. (Second 100 Whites.) No. of Deaths among foregoing.	Group C. (Remaining 93 Whites.) No. of Cases in which Symptoms mentioned occurred.	Group C. (Remaining 93 Whites.) No. of Deaths among foregoing.	Group D.	Group E. (10 Chinese.) No. of Cases in which Symptoms mentioned occurred.	Group E. (10 Chinese.) No. of Deaths among foregoing.	Totals. No. of Cases.	Totals. Deaths	Totals. Per-centage of Deaths.
Femoro-Inguinal Chain only. Right.	Femoral	30	10	16	4	12	2	The cases in Group D are those of inoculated persons, and have been reckoned in the previous columns of this Table.	1	...			
	Inguinal	5	2	10	2	10	1		1	1			
	Femoral and Inguinal	3	1	5	1	4	...		1	...			
	Femoral or Inguinal	1	...	...	...	...	...		...	...			
	Femoral, Inguinal, and Iliac	1	1	1	1	...	...		...	...			
	Groin	1	...	..	...	...	...		...	...			
		41	D. 34·1 % 14	32	D. 25 % 8	26	D. 11·5 % 3		3	D. 33·3 % 1	102	26	25·5
Femoro-Inguinal Chain only. Left.	Femoral	25	7	21	7	16	3		...	...			
	Inguinal	8	2	5	2	5	...		...	...			
	Femoral and Inguinal	7	1	5	1	7	...		...	...			
	Femoral, Inguinal, and Iliac	1	1	...	...	...	...		...	...			
	Groin	1	...	...	...	...	...		...	...			
		42	D. 26·2 % 11	31	D. 32·2 % 10	28	D. 10·7 % 3		...	...	101	24	23·7
Femoro-Inguinal Chain only. Bilateral.	Right and Left Femoral	...	...	3	...	...	...		...	...			
	Right Femoral and Left Popliteal	...	...	1	...	...	...		...	...			
	Right and Left Femoral and Left Inguinal	...	...	1	1	...	...		...	...			
	Right and Left Inguinal	...	...	...	...	3	...		1	1			
	Right Femoral and Left Inguinal	...	...	...	...	1	1		...	...			
		...	...	5	D. 20 % 1	4	D. 25 % 1		1	D. 100 % 1	10	3	30·
		83	D. 30 % 25	68	D. 28 % 19	58	D. 12 % 7		4	D. 50 % 2	213	53	25·
Axillary Chain.	Right Axillary	1	1	1	...	7	5		...	...			
	Left Axillary	4	2	1	...	2	...		1	1			
	Right and Left Axillary	1	1	3	1	3	1		...	...			
	Right Subpectoral	2	2	1	...	3	1		...	...			
	Left Subpectoral	...	...	1	1	1	1		...	...			
	Right Subpectoral and Right Axillary	...	...	1	...	..	...		...	...			
		8	D. 75 % 6	8	D. 25 % 2	16	D. 50 % 8		1	D. 100 % 1	33	17	51·5
Cervical Chain.	Right Cervical	2	...	1	1	3	...		...	...			
	Left Cervical	2	2	3	2	...	...		1	1			
	Parotid	1	...	...	...	...	...		...	...			
	Right and Left Cervical	...	...	...	...	1	1		1	1			
		5	D. 40 % 2	4	D. 75 % 3	4	D. 25 % 1		2	D. 100 % 2	15		53·3
Axillary, Cervical, and Others Combined.	Right Axillary, Cervical, and Femoral	1	1	...	...	...	...		...	...			
	Right Femoral, Right and Left Axillary, Left Cervical	...	...	1	1	...	...		...	...			
	Left Cervical and Left Axillary	...	...	1	...	1	1		...	...			
	Right Femoral, Left Axillary, Right and Left Cervical	...	...	1	...	...	...		...	...			
	Right Femoral and Left Axillary	...	...	1	1	1	1		...	...			
	Right and Left Cervical	...	...	1	1	...	...		..	...			
	Right and Left Femoral and Cervical, and Right Axillary	...	...	1	1	...	...		...	...			
	Right Axillary, Right and Left Femoral	...	...	1	...	...	...		...	...			
	Right Cervical and Left Axillary	...	...	1	...	1	...		...	...			
	Right and Left Cervical, and Left Femoral	...	...	1	1	...	...		...	...			
	Right and Left Axillary, Right Supratrochlear	...	...	1	1	...	...		...	...			
	Right Femoral and Axillary	...	...	1	1	1	...		...	...			
	Right Femoral, Left Cervical, and Iliac	...	...	1	...	...	...		...	...			
	Supratrochlear and both Cervical	...	...	1	...	...	..		...	...			
	Sublingual and Left Cervical	...	...	...	...	1	...		...	...			
	Right Inguinal and Axillary	..	...	...	...	1	...		...	...			
	Right Inguinal, Femoral, and Cervical	...	...	...	...	1	...		...	...			
	Right Axillary and Cervical	...	...	...	...	1	...		...	...			
	Right Brachial and Axillary	...	...	...	...	1	...		...	...			
	Right Femoral, Inguinal, Right and Left Cervical	...	...	..	...	1	...		...	...			
	Right Cervical, Left Subpectoral	...	...	...	...	1	...		...	...			
		1	D. 100 % 1	13	D. 53·9 % 7	11	D. 18·2 % 2		...	...	25	10	40·
	Totals	...	97 D. 35 % 34	93	D. 33·3 % 31	89	D. 20·2 % 18		7	D. 71·4 % 5	286	88	30·8
	Cases in which no Buboes occurred (Septicæmic)	...	3 D. 100 % 3	7	D. 86 % 6	4	D. 75 % 3		3	D. 100 % 3	17	15	88·2
			100 37	100	37	93	D. 22·6 % 21		10	D. 80 % 8	303	103	34·

A. E. SALTER, M.B.

APPENDIX C.

Notes on some Lesions of the Eye; by C. Gordon McLeod, M.B., Ch.M.

On April 14th I visited the Quarantine Hospital at North Head, and examined four patients suffering from eye trouble. They were as follows:—

Case 10.—Right eye; large superficial corneal ulcer of dendritic type; little photophobia; moderate ciliary congestion; no hypopyon.
Case 17.—Right eye; extensive exudation of pure lymph in anterior chamber; subsiding iritis, with closed pupil. No keratitis.
Case 86.—Both eyes; slight attack of simple iritis.
Case 40.—Left eye; small central cornial ulcer, with considerable iritis.

In case 17, the eye lesion appears to be specific to the general disease from which the patient is suffering. The entire absence of outside causes points to a septic embolus setting up a disastrous intra-ocular suppuration.

As to the other cases, there is nothing in the appearances to distinguish them from similar trouble occurring under many other circumstances; but as keratitis and iritis have been frequently noted in the course of plague, their presence here is probably more incidental than accidental.

APPENDIX D.

Post-mortem notes made on twenty-four cases of plague by the Government Pathologist (Dr. G. H. Taylor), by the Pathologist to Sydney Hospital (Dr. Sydney Jamieson), and by Dr. F. P. Sandes, Resident Medical Officer, Prince Alfred Hospital.

Case 22. *March* 17. *F., æt.* 14. *Duration of illness, 30 hours.*

Body well nourished. Skin pale. No enlarged glands. Hæmorrhage around the femoral glands, but no œdema. Arachnoid and pia mater much congested. Small hæmorrhages scattered over pulmonary pleura, upper surface of diaphragm, costal pleura, surface of heart, interior of heart and pericardium, the capsule of kidneys, and surface of intestines. Several of these hæmorrhages appeared to have a slightly necrotic centre. Hæmorrhage into the mucous coat of stomach. The hæmorrhages varied in size from a pin's head to a three-penny piece. The lungs were congested and œdematous. The liver slightly fatty. The spleen normal in size and firm. Colour of splenic pulp a dark red. Dr. Armstrong removed a piece of the spleen.

G.H.T.

Case 58. *April* 1. *M., æt.* 43. *Duration of illness, 7 days.*

External appearances.—Fairly well nourished. Body pale. Rigor mortis universally present. *Post-mortem* lividity very marked over dependent parts of body. A few small livid petechiæ, about size of pin-heads, were found in the anterior aspects of both legs.

Lymphatic Glands.—The axillary, brachial, and inguino-femoral glands were dissected out. In the case of the latter groups some of the glands were slightly enlarged, and on section were softened and somewhat mottled, but no hæmorrhagic extravasation was found around them.

Thorax.—Cavities: Contained no subserous hæmorrhages and no excess of fluid.

Lungs.—Both were somewhat congested and slightly œdematous, but were otherwise normal. The glands at the roots of the lungs were normal in appearance. No petechial hæmorrhages were found in the pleuræ.

Heart (weight 10¾ oz.).—Both ventricles were filled by pale yellow gelatinous clot, which was tightly adherent to the meshes of the columnæ carneæ. Otherwise the organ was healthy looking.

Abdomen.—Peritoneum healthy. No petechial hæmorrhages.

Liver.—Enlarged (weight, 5 lb. 8¾ oz.). It was of a uniform yellow colour, and of soft consistence. This was found microscopically to be due to an extensive fatty degeneration of the liver.

The gall-bladder and its contents appeared normal.

Stomach and Intestines.—In the stomach were numerous submucous extravasations of blood, especially towards its cardiac end. The mucous membrane was corrugated and covered by a thick, glairy, tenacious mucus.

The mucous membrane of the intestines was slightly congested, but otherwise normal.

Genito-urinary System.—Right kidney (6¾ oz.): Organ swollen, and of soft consistence. Its cortex was pale and swollen. On section the kidney substance overlapped the divided capsule. The capsule was thin, translucent, and non-coherent.

Left Kidney (7¼ oz.).—Similar to its fellow.

Microscopically the kidneys showed proliferation and desquamation, with cloudy swelling of the tubular epithelium, and also of the epithelial lining of the Bowman's capsules.

The bladder and ureters showed nothing abnormal.

Hæmopoietic System.—The spleen was enlarged; somewhat softer than normal. On section the pulp had a brownish-red colour, and the trabeculæ were obscured by the swelling of the pulp.

The

The mediastinal and mesenteric glands were unaffected, but chains of vessels running along both iliac vessels were somewhat enlarged and redder than normal.

Nervous System.—The brain showed nothing abnormal save some slight excess of fluid beneath the lepto-meninges.

Films from the spleen pulp and the blood of the right median basilic vein were made and stained by dilute aqueous solution of fuchsin, and showed numerous short oval-shaped bacilli, many of which showed characteristic bipolar staining.

Films were also stained by Gram's method, and showed the bacilli to be decolourised. S.J.

Case 78. *April* 6. *M., æt.* 18. *Duration of illness, 72 hours.*

Body pale, but cyanosed. Numerous small excoriations in both forearms, the result of scratching—resulting from the irritation of mosquito bites. Some abrasions on lower parts of both legs. No petechiæ. The inguino-femoral glands and the glands above Pouparts' ligament on the right side were enlarged.

Thorax.—Cavities: Nil.

Lungs.—Nothing abnormal, except a few small petechial hæmorrhages. Heart.—Muscle apparently healthy. All its cavities were completely filled by pale yellow gelatinous clot, firmly adherent to columnæ carneæ. Valves and aorta healthy.

Abdomen.—Liver: Enlarged and mottled. Gall, bladder, and bile apparently normal. Stomach and intestines.—Mucosa of stomach swollen and mamillated, and covered with ropy mucus. Numerous petechiæ in the submucous coat. In some parts of the large intestine there were many submucous hæmorrhages, some as large as a three-penny piece.

The mesenteric glands were enlarged, but not hæmorrhagic.

Genito-urinary System.—Kidneys enlarged, and softer than normal. Cortex swollen and pale. No hæmorrhages in substance or capsule. Capsule stripped readily.

Bladder and Ureters.—Healthy.

Hæmopoietic System.—Spleen: Slightly enlarged, and somewhat soft. On section of a dark reddish-brown colour.

Nervous System.—Brain healthy. The iliac and inguino-femoral glands on the right side were enlarged and softened. On section they were dark and mottled, and there was a considerable amount of peri-capsular hæmorrhage. There was also marked œdema (inflammatory) of the retro-peritoneal tissue in both iliac regions.

The blood, spleen, and enlarged glands all showed numerous plague bacilli. S.J.

Case 79. *April* 6. *F., æt.* 61. *Duration of illness, 7 days.*

Heart and lungs not examinad. Axillary glands enlarged. Femoral glands not increased in size. Liver normal in appearance. No superficial hæmorrhage. Spleen enlarged somewhat, soft, darker colour than normal; no superficial hæmorrhages. Intestines normal. Mesenteric glands firm and rather prominent. Kidneys healthy. F.P.S.

Case 84. *April 7th. M., æt.* 3. *Duration of illness, 51 hours.*

External appearances.—Rigor mortis universally present. *Post-mortem* lividity well marked. Numerous petechiæ on chest, abdomen, and legs. No definite bubo to be made out.

Thorax.—Cavities: Empty. No petechial hæmorrhages.

Lungs.—Somewhat congested. There were a few petechial sub-pleural hæmorrhages, otherwise nothing abnormal found.

Heart.—Showed nothing abnormal except some pallor of its muscular walls.

Abdomen.—Peritoneum: No petechiæ; no abnormality observed.

Liver.—Somewhat enlarged and softened. It was very much mottled in appearance, and was found to be the seat of an extensive fatty degeneration.

The gall bladder and its contents showed nothing unusual.

Stomach and Intestines.—The stomach showed a few submucous hæmorrhages. The small intestine showed some swelling and infiltration of the solitary glands and Peyer's patches. Throughout the whole length of the intestines were found numerous small submucous hæmorrhages.

The pancreas was the seat of a somewhat extensive hæmorrhagic extravasation, both into its substance and beneath its serous coat.

Genito-urinary System.—Right kidney was enlarged and softer than normal. The capsule was tightly stretched over the organ. It stripped readily. No hæmorrhagic extravasations were found either in the substance of the organ or beneath its capsule.

The cortex was pale and swollen, and found to be the seat of an early catarrhal nephritis (microscopically).

Left kidney similar to its fellow.

Bladder and ureters.—Healthy.

Hæmopoietic System.—The spleen was enlarged and of subnormal consistence. Its pulp was of a light brownish-red colour, and its trabeculæ were obscured.

The lymphatic glands along the course of the iliac and femoral vessels were slightly enlarged and of a dark-red colour. On section they were found to be of soft consistence and to be markedly mottled. Around these enlarged glands was an area of subserous hæmorrhages.

The brain showed no abnormality.

Microscopic examination of the spleen pulp and blood was made, and enormous numbers of typical plague bacilli were found.

The blood, in addition, was found to show a very extensive leucocytosis and there were present also numerous myelocytes and nucleated red corpuscles. S.J.

Case 93. *April* 9. *M., æt.* 22. *Duration of illness,* 36 *hours.*

Died 8th April. Body, face, and neck cyanosed. No petechiæ. Femoral, inguinal, and iliac glands, red in colour and mottled in section, not enlarged: surrounded by hæmorrhage. Lungs œdematous and congested with numerous small sub-pleural hæmorrhages. Hæmorrhage in pericardium and surface of heart. Heart contained dark clots. Liver mottled with patches of fatty degeneration. Spleen slightly enlarged and softer than normal. A few hæmorrhages on surface of intestines. A few submucous hæmorrhages in stomach. Large sub-capsular hæmorrhages in kidney.

Death reported to coroner as due to plague. Spleen and blood afterwards examined by Dr. Bowker, who confirmed the opinion, which was quite clear from the *post-mortem.* G.H.T.

Case 111. *April* 13. *M., æt.* 36. *Duration of illness,* 36 *hours.*

The body was that of a well-nourished and fairly muscular man; skin pale, and face placid. Hæmorrhage around the inguinal bubo, and œdema; hæmorrhage around the femoral, iliac up to the lumbar glands. A few petechiæ in the pulmonary pleura. Lungs œdematous. Dark soft clots on both sides of heart, with soft pale clot in right ventricle. Muscle and valves normal. Scattered hæmorrhage in posterior mediastinium. Hæmorrhage around round ligament of liver. Scattered petechiæ on surface of liver. Subserous and submucous hæmorrhages in gall-bladder. Hæmorrhages into pancreas and into retro-peritoneum and surface of kidneys. Spleen normal in size and consistence, dark red in colour. Many small areas of congestion in arachnoid, which, from simple inspection, resembled hæmorrhages (small).

G.H.T.

Case 114. *April* 15. *M., æt.* 62. *Duration of illness,* 48 *hours.*

Body fairly nourished. Numerous petechiæ all over the body. No wounds or abrasions of any sort. Double inguinal hernia. Decomposition signs showing in legs and lower abdomen.

Thorax.—Lungs: Both were markedly congested. A few small sub-pleural hæmorrhages.

Heart.—A few sub-epicardial hæmorrhages. Marked *post-mortem* staining of the endo-cardium. Heart muscle soft and flabby. Badly formed pale clots on both sides.

Abdomen.—Liver: A few small sub-capsular hæmorrhages. Organ slightly pale, but no marked fatty change. Consistence soft.

Stomach.—Showed some small hæmorrhages near the pyloric end.

Kidneys.—Very soft, and somewhat swollen. Cortex swollen, especially the inter-pyramidal portion.

Bladder and Ureters.—Showed some sub-peritoneal hæmorrhages over the fundus of the bladder.

Spleen.—Much enlarged and very soft in consistence.

Brain.—Nothing abnormal.

Lymphatic Glands.—The left inguinal and iliac glands were slightly enlarged and discrete. There were some hæmorrhages around the iliac glands.

Films from the blood and spleen pulp showed a few plague bacilli and numerous streptococci. Films from the enlarged gland showed numerous plague bacilli.

S.J.

Case 129. *April* 21. *F., æt.* 68. *Duration of illness,* 24 *hours.*

All the organs were very much congested and in a decomposing state; they were also, especially the liver, full of air cavities. Heart showed old mitral disease. Liver not enlarged. Spleen not enlarged. Numerous hæmorrhages in the capsule. Hæmorrhage along the line of iliac vessels. Brain, like other organs, soft and congested. Smear preparations from blood in iliac vein, and also from spleen, showed numbers of bacilli corresponding to those of pestis bubonica with bi-polar staining, also proteus vulgaris.

S.J.

Case 132. *April* 22*nd. F., æt.* 17. *Duration of illness,* 96 *hours.*

Body well nourished. A few petechiæ about the legs. Large swellings on both sides behind and below the angles of the lower jaw.

Thorax.—Cavities: No gland or adhesions.

Lungs.—Over both pleural surfaces were a few subserous hæmorrhages. Both were slightly congested, but otherwise healthy.

Heart.—Muscle firm and pale. The right ventricle was filled by mixed clot. Valves and endo-cardium healthy.

Abdomen.—Peritoneum: Several small hæmorrhages seen beneath the peritoneum covering the lumbar portion of spine.

Liver.—Numerous small hæmorrhages on anterior surface of liver and over the fundus of the gall-bladder. Scattered through the substance of the liver were numerous small pin-point white masses closely resembling miliary tubercles. Some of these were surrounded by hæmorrhage

Stomach and Intestines.—A few submucous hæmorrhages in the stomach.

Genito-urinary System.—Both kidneys were slightly enlarged and showed a few sub-capsular hæmorrhages. Cortex swollen and pale in both. Bladder and Ureters: Nil.

Uterus: Small. Tubes and ovaries congested, but no hæmorrhages around them.

Hæmopoietic System.—Spleen: Enlarged and softer than normal. On section of a dark reddish-brown colour.

Tonsils.—On the surfaces of both were sloughy patches, and on squeezing them a puriform fluid exuded from the crypts.

The lymphatic glands at the root of the mesentery below the pancreas were enlarged and softened and had hæmorrhage around them.

The glands on either side of the neck near the angle of the jaw were somewhat enlarged, softened, and mottled in appearance. They were absolutely embedded in a tissue composed of extravasated blood and inflamed cellular tissue. This appearance was visible along the entire course of both sterno-mastoid muscles.

Brain.

Brain.—Somewhat hyperæmic, but otherwise normal.

Microscopic examination of the blood, spleen pulp, and the juice of the enlarged cervical glands showed numerous plague bacilli.

The puriform fluid from the faucial tonsils was inoculated upon some sloped serum (solidified). In eighteen hours a copious growth took place, which was found to consist of rod-shaped organisms closely resembling the Bacillus Coli Communis. No Klebs Loeffler bacilli were found.

S.J.

Case 140. *April* 24. *M.*, *æt.* 59. *Duration of illness*, 5 *days.*

Body rather obese. Small bruise over left eye. Numerous petechiæ on trunk and limbs. Rigor mortis and lividity well marked.

Thorax.—Lungs: Showed nothing unusual.

Heart.—Apparently healthy; full of pale yellow gelatinous clot on both sides.

Abdomen.—Peritoneum: Showed no petechiæ.

Liver.—Enlarged. Very fatty, and in an advanced stage of cirrhosis.

There were numerous hæmorrhagic points in the mucous coat of the gall-bladder.

Spleen.—Very large (about twice its normal size). On section it was found to be very soft and of a dark reddish-brown colour. Its trabeculæ were obscured.

Kidneys.—Both were enlarged; softer than normal. Numerous small sub-capsular hæmorrhages. Capsule was thin and non-adherent. The cortex was pale, swollen, and slightly mottled.

Lymphatic System.—No enlargement or sign of disease was found in any of the lymphatic glands.

A microscopic examination of the spleen pulp showed numerous typical plague bacilli present.

S.J.

Case 142. *April* 25. *M.*, *æt.* 5. *Duration of illness*, 51 *hours.*

Body well nourished; skin pale, excepting slight *post-mortem* lividity on back. No enlarged glands. Hæmorrhage around the femoral, inguinal, and iliac glands on left side. Glands slightly inflamed. Lungs slightly œdematous, with a few petechiæ in pulmonary pleura. Liver slightly enlarged. Hæmorrhage into pancreas. Spleen normal in size and firmness. Splenic pulp dark red in colour. Heart contained dark and pale clots.

Piece of the spleen afterwards handed to Dr. Tidswell. G.H.T.

Case 143. *April* 25. *M.*, *æt* 49. *Died in a Public-house bar. No information.*

A few petechiæ were present on the arms and legs. *Post-mortem* lividity and rigidity were both well marked.

Thorax.—The lungs showed nothing abnormal.

The heart showed nothing abnormal, except a few petechiæ on the visceral pericardium. It contained dark fluid blood.

Abdomen.—Peritoneum: There were numerous petechiæ upon the serous coats of the intestines.

Liver.—Somewhat enlarged and fatty.

Spleen.—Slightly enlarged; of firm consistence. On section of a dark reddish-brown colour.

The kidneys were swollen and pale. The cortices were somewhat swollen.

There was no evidence of enlargement of the lymphatic glands in any part of the body.

Microscopic films of the splenic pulp showed enormous numbers of plague bacilli.

S.J.

Case 173. *May* 3. *F.*, *æt.* 56. *Duration of illness*, 9 *days.*

Body very obese. Face and neck much swollen, livid, and congested. *P.M.* lividity very marked.

Thorax.—Cavities: No hæmorrhages or fluid. Lungs: Engorged, but otherwise normal. Heart (13¾ oz.): Muscle pale; both ventricles and auricles contained a small amount of mixed clot.

Abdomen.—Peritoneum: Nil.

Liver.—Slightly enlarged, of soft consistence. Had a mottled appearance. No sub-capsular hæmorrhage. Liver evidently fatty.

Stomach and Intestines.—A few small submucous petechiæ in the stomach. Intestines were in places somewhat congested looking.

Genito-urinary System.—Both were enlarged and of rather soft consistence. On section they were dark and cyanotic. Cortex swollen. Capsule healthy.

Hæmopoietic System.—Spleen: Slightly enlarged; darker than normal; on section it was of about normal consistence and of a mahogany colour. Brain: Nil. Lymphatic Glands: In the right femoral region was an enlarged gland, about the size of a small hen's egg. The inguinal glands were also enlarged. The glands along the iliac vessels were also enlarged. All these glands were softened and somewhat mottled, and were surrounded by areas of extravasated blood.

Microscopic examination of the blood, spleen pulp, and the juice of the enlarged glands showed numerous plague bacilli.

S.J.

Case 184. *May* 2. *M.*, *æt.* 59. *Duration of illness*, 75 *hours.*

Body well nourished. Rigor mortis universally present. *Post-mortem* lividity well marked. A few small petechiæ on legs and flanks. An enlarged gland could be felt in the left groin.

Thorax.—Lungs: Somewhat congested, but otherwise normal. Heart: Showed nothing abnormal. No ecchymoses in pleural or pericardial serous sacs.

Abdomen.—Liver: Slightly enlarged and mottled. A few petechial hæmorrhages found beneath the capsule of Glisson.

Spleen.—Enlarged; somewhat subnormal in consistence. On section the pulp was found to be softened and of a dark reddish-brown colour.

Kidneys.—Enlarged; capsule stripped readily; cortex pale and swollen.

Bladder

Bladder and Ureter.—Healthy.

Stomach and Intestines.—Showed nothing abnormal, except that there were a few petechiæ in the mucous membrane of the stomach near its cardiac end.

Pancreas.—Nil.

The femoral group of glands in the left groin were enlarged, softened, and surrounded by hæmorrhage. On section they were mottled.

Microscopic films from the spleen and enlarged glands showed numerous plague bacilli.

S.J.

Case 197. *May* 6. *F., æt.* 5. *Duration of illness*, 48 *hours.*

Body was well nourished. A few petechiæ about the neck. On left side of neck, a little below the ear, I found a bubo about the size of a pigeon's egg. On cutting into this I found the gland surrounded by hæmorrhage, with œdema of the adjoining tissues. Slight œdema of the lungs, with numerous petechiæ in pulmonary pleura. Heart contained dark and soft pale clots. Liver soft and fatty. Hæmorrhage into pancreas. Small hæmorrhages on surface of liver, intestines, and kidneys. Spleen normal in size, not softened. Splenic pulp red in colour.

Death due to plague. This was afterwards confirmed by an examination of the spleen made by Dr. Tidswell.

G.H.T.

Case 198. *May* 7. *F., æt.* 65. *Duration of illness*, 6 *days.*

The body was that of a stout, well-nourished woman; skin was pale, excepting slight *post-mortem* lividity over the back; the face was placid. No enlarged glands. Lungs œdematous. Heart soft and fatty; dark and soft pale clots on both sides. Liver enlarged and fatty. Spleen much enlarged and soft. Splenic pulp very dark in colour. Kidneys cirrhotic. The femoral glands on right side were deeply congested, but not enlarged, and the tissues around them appeared to be normal. I dissected out the inguinal, axillary, and cervical glands, and found nothing abnormal. No trace of hæmorrhage, excepting a small patch, close to right ovary, which was bound down by old adhesions to the peritoneum; the hæmorrhage was beneath the peritoneum, and very dark in colour.

G.H.T.

Case 226. *May* 15. *M., æt.* 28. *Duration of illness*, 24 *hours.*

Well-nourished, muscular Chinaman. Body and face livid; hands clenched. Numerous petechiæ in neck and chest. Bubo about size of a hen's egg, a little behind and below the left ear, On cutting into this I found hæmorrhage surrounding the gland with œdema of the adjoining tissues. Lungs congested, and slightly œdematous. Small scattered hæmorrhages in pulmonary pleura, and pericardium; also on surface of heart. In the centre of several of these hæmorrhages there appeared to be a necrotic spot. The heart contained a quantity of imperfectly clotted dark blood. Numerous hæmorrhages on surface of liver and kidneys. Liver enlarged and fatty. Spleen slightly enlarged and soft, of a dark red colour.

G.H.T.

Case 234. *May* 18. *M., æt.* 20. *Duration of illness*, 7 *days.*

Body spare. Rigor mortis present, but not yet complete. Body still warm. Lividity marked. No petechiæ. Enlarged gland felt in left groin.

Thorax.—Lungs: Deeply engorged, but otherwise normal. Heart: Somewhat flabby, but otherwise not abnormal. Both sides filled with whitish-yellow gelatinous clot.

Abdomen.—Liver: Not enlarged. Numerous subcapsular hæmorrhages. Organ very soft and extensively fatty.

Spleen.—Very large (about twice normal size), of subnormal consistence. On section of a dark red colour. Pulp very soft. Trabeculæ obscured.

Kidneys.—Softer than normal. Cortex swollen and pale and speckled with numerous pin-point hæmorrhages. Capsule thin and non-adherent.

Lymphatic Glands.—One of the femoral glands on the left side was enlarged slightly and surrounded by sub-capsular hæmorrhage. On section it had a mottled appearance.

Films were made both of the spleen pulp and of the juice of the enlarged gland. In the former no plague bacilli were found, whereas the latter contained typical plague bacilli in great abundance.

S.J.

Case 238. *May* 19. *M., æt.* 70. *Duration of illness*, 48 *hours.*

Body well nourished. Rigor mortis and lividity both present, the latter excessive. A few small petechiæ about the size of pin-heads were scattered over the trunk and limbs.

Thorax.—Both lungs were the seat of a chronic interstitial pneumonia, the result of irritation from inhaled coal pigment. There were no petechiæ on the pleura. The bronchial mucous membrane was swollen and reddened, and the tubes contained a quantity of frothy muco-purulent matter.

The heart showed nothing abnormal, except that its right side was distended by pale yellowish gelatinous firmly adherent clot.

Abdomen.—Peritoneum healthy. Liver enlarged and mottled in patches. There were numerous hæmorrhages of small size into its capsule. Spleen enlarged, somewhat softer than usual. Its pulp was of a dark reddish-brown colour. The trabeculæ were obscured owing to the swelling of the pulp.

The kidneys were swollen and of soft consistence. These capsules stripped readily. Cortices were pale, somewhat mottled and swollen. On division of the capsule the kidney substance "lipped" over the divided capsule. The other organs in the abdomen showed nothing abnormal.

Lymphatic Glands.—One of the glands in the left femoral region was swollen, enlarged, and surrounded by a zone of hæmorrhage. On section it was soft and had a mottled appearance. The other glands showed nothing abnormal.

Microscopic examination was made of films from the spleen and enlarged gland, and large numbers of plague bacilli were found.

S.J.

Case 240. *May* 20. *M., æt* 45. *Duration of illness,* 12 *hours.*

Body very obese. A few petechiæ were found on the trunk and limbs.

Thorax.—Lungs somewhat engorged. Heart.—The walls of the heart, especially the left ventricle, were of soft consistence, and mottled from early fatty degeneration. The cavities of the organ contained a small quantity of dark fluid blood. Valves were healthy.

Abdomen.—Liver markedly enlarged, and the seat of extensive fatty degeneration. Spleen enlarged, of normal consistence. On section of a dark red colour. Trabeculæ obscured.

Kidneys somewhat enlarged and of soft consistence. On section the capsule stripped readily. The cortex was paler than usual and mottled throughout with numerous pin-point hæmorrhages. Stomach showed evidence of chronic gastric catarrh, and also numerous recent submucous hæmorrhages.

Lymphatic Glands.—In the right femoral region one of the glands was found to be swollen slightly, and to be surrounded by a small hæmorrhagic zone. On section it had a mottled appearance.

Microscopic examination of the spleen and lymphatic gland pulps showed numerous plague bacilli.

S.J.

Case 242. *May* 21. *M., æt* 17. *Duration of illness,* 12 *hours.*

External appearances.—A few petechiæ on sides of chest and on back. Rigor mortis present. Lividity marked. The glands in both inguino-femoral regions were felt to be enlarged and "shotty."

Thorax.—Lungs somewhat engorged. No sub-pleural hæmorrhages. Heart apparently healthy. A parti-coloured clot filled the right auricle and ventricle.

Abdomen.—Liver enlarged and slightly mottled. A few petechial hæmorrhages beneath the capsule of Glisson. In one small area in the substance of and on the surface of the organ was a group of small pin-point yellowish-white bodies closely resembling miliary tubercles. Spleen enlarged and almost semi-diffluent. On section it was of a dark reddish-brown colour.

Kidneys beyond being somewhat congested showed no abnormality.

Stomach.—The mucous membrane was swollen, red, mammillated, and at the cardiac end were numerous small submucous hæmorrhages.

Lymphatic Glands.—The glands in both inguino-femoral regions were found to be somewhat enlarged. In consistence they were harder than normal (resembling the condition seen in syphilitics). One of the femoral glands on the right side was somewhat redder than the rest, and on section were somewhat mottled.

Microscopic Examination.—Films were made, both of the spleen pulp and of the pulp of the gland described above. No organisms resembling the plague bacillus were found in the spleen, but the film taken from the gland contained innumerable plague bacilli.

S.J.

Case 255. *May* 31. *M., æt* 55. *Duration of illness,* 15 *hours.*

The body was that of a muscular and well-nourished man; the face and neck deeply cyanosed; the mouth contained some semi-digested food. No enlarged glands. Old pleuritic adhesions in both sides of chest, the large bronchi inflamed, and the lungs somewhat congested. Heart large. Left ventricle hypertrophied; heart much diseased. Coronary vessels slightly atheromatous. Dark clots in both sides. Liver in an advanced stage of cirrhosis. Kidneys granular. Stomach contained a quantity of food; its mucous coat in a condition of chronic inflammation. Spleen enlarged; softer than normal. This appeared to be a recent change, and was a little suggestive of plague.

In the brain the arachnoid was thickened and opaque, with some atrophy of the convolutions.

A piece of the spleen was removed and handed to Dr. Tidswell, and, after examination, the case was reported as one of plague.

G.H.T.

Case 295. *June* 29. *M., æt.* 55. *Duration of illness,* 70 *hours.*

Body very emaciated. A swelling about the size of a hen's egg in the right groin. Numerous petechiæ on the trunk and limbs. On the right leg were two small vesicular papulæ, which looked as though they had had their heads scratched off.

Thorax.—Both pleural sacs were entirely obliterated by old, tough, fibrous adhesions, the result of previous repeated attacks of pleurisy.

Lungs.—At the apices of both lungs were old deposits of chronic fibroid tubercle, and in the upper lobe of the right lung was a somewhat more recent spread of miliary tubercle. The bronchi showed signs of chronic catarrhal inflammation.

Heart.—There was considerable hypertrophy of the right ventricle. Both ventricles were distended by blood clot; that on the right side was for the most part of a yellowish-white colour, and slightly adherent to the columnæ carneæ. On the left side the clot was dark-coloured and very "crumbly." At the root of the aorta was some evidence of advanced atheroma; otherwise the heart showed no abnormality.

Abdomen.—There were no ecchymoses on the peritoneal covering of the intestines.

Liver.—Very soft and flabby, and of a pale yellow colour. On its surface were numerous small hæmorrhages beneath the capsule.

Spleen.—Enlarged; fairly firm in consistence, and of a dark reddish-brown colour.

Kidneys.—Both were enlarged and obviously congested. The cortex was swollen, and paler than normal.

Brain.—Nothing abnormal found.

The femoral and inguinal glands on the right side were enlarged and somewhat softened. They were surrounded by a small amount of hæmorrhagic extravasation. On section they were mottled in appearance. The glands along the line of the external and common iliac arteries on both sides were somewhat enlarged, and of a dark red colour.

Films of the blood, spleen, and enlarged lymphatic glands contained enormous numbers of plague bacilli.

S.J.

APPENDIX E.

Cases treated with Yersin-Roux Serum.

TABLE showing particulars of all cases admitted on and after May 13th (Case 217), when Serum first became available, and distinguishing those (22) which did not receive it. The first 6 were admitted before May 13th, and were treated merely because their cases were almost desperate. From Dr. Salter's clinical notes.

Consec. No.	Sex.	Age.	Day of illness on which admitted.	(1) Days of illness on which Serum was injected. (2) Quantity in Cub. Cents. (3) Place of injection (S. = Subcutaneously; V. = Intravenously).	Day after attack on which Patient—		Remarks.
					Was discharged.	Died.	
201	F	10	3rd	5/20 V	...	6th	Left cervical bubo; slight enlargement and tenderness of glands in both axillæ, and femoral gland on one side.
202	M	30	7th	9/20 V, 11/40 S, 12/20 S. 13/40 S, 15/20 V.	...	16th	Chinese; right inguinal bubo; steadily declined from attack.
204	M	19	4th	7/40 S, 8/20 V, 9/20 V ...	...	11th	Septicæmic form; on 7th day right cervical gland became slightly enlarged, and others at later dates.
205	M	28	3rd	7/40 S	...	8th	No buboes; right femoral gland and right axillary became slightly enlarged on 3rd day.
208	F	16	3rd	8/20 V	42nd	...	Bubo, subpectoral on right side, and left cervical; afterwards right femoral also.
216	F	29	3rd	3/20 S	97th	...	Bubo, left femoral; extreme lethargy on admission.
217	F	14	3rd	.....	32nd	...	*No serum;* left femoral bubo; had a vesicular eruption considered to be chickenpox (which others in the family had lately had); hæmorrhage occurred into each vesicle.
218	M	15	2nd	2/40 S, 3/20 V, 7/20 S, 8/20 V.	75th	...	Left femoral bubo; no other enlargement.
219	M	45	4th	.....	56th	...	*No serum;* right femoral bubo; did not appear very ill on admission; T. 101, P. 92; T. fell to normal next day and never rose again.
220	F	23	4th	5/40 S	76th	...	Admitted 4th day; moderate attack.
221	F	15	5th	4/30 S	76th	...	Left femoral bubo only.
222	M	38	5th	5/40 S	76th	...	Some tenderness and indistinct swelling in both axillæ; T. 100, P. 80, on admission.
223	M	15	5th	.....	41st	...	*No serum;* admitted 5th day; left inguinal bubo; T. 98·4, P. 68, on admission; was never worse.
224	F	14	6th	6/40 S	53rd	...	Left femoral bubo; T. 99, P. 92, on admission; was never worse.
225	M	16	2nd	2/40 S, 3/20 V, 4/20 S, 5/20 S.	42nd	...	On first day (evening) T. 103; P. dicrotic and very rapid, lethargic; face pallid. On admission 2nd day, almost comatose; T. 99·2.
226	M	28	.....	.....	...	...	*Died before reception;* Chinese.
227	M	26	2nd	1/40 S, 2/40 S, 6/20 V, 7/20 S.	...	7th	Right axillary bubo; other glands slightly enlarged; delirium and stupor at end of 1st day of illness; serum temporarily exhausted.
228	M	11	7th	7/20 S	35th	...	Notified 7th day; small right femoral bubo; a slight case.
229	M	43	1st	1/40 S	29th	...	Left femoral; did not appear to be very ill on admission.
230	M	20	.....	3/40 S	...	3rd	Right inguinal; on discovery patient too ill to remove; died same day.
231	F	40	4th	3/30 S	80th	...	Left femoral only; a moderately severe case.
232	M	38	.....	.....	...	...	*Died before reception.*
233	F	35	5th	5/40 S	31st	...	Left femoral; a mild case.
234	M	20	.....	.....	...	...	*Died before reception.*
235	M	46	6th	6/40 S	100th	...	A diabetic.
236	M	24	5th	.....	42nd	...	*No serum;* supply threatened to run short temporarily; patient hardly exhibited any constitutional symptoms on admission.
237	F	44	9th	.....	34th	...	*No serum;* admitted 9th day, and showed no constitutional symptoms.
238	M	70	.....	.....	...	...	*Died before reception.*
239	M	41	2nd	.....	33rd	...	*No serum;* although the bubo was axillary, and patient admitted on 2nd day of illness, he offered very slight symptoms of constitutional illness; he was said to have been very delirious during the night which followed attack.
240	M	45	.....	.....	...	...	*Died before reception.*
241	M	4	.....	.....	...	...	*Died before reception.*
242	M	17	.....	.....	...	...	*Died before reception.*
243	M	28	8th	8/40 S, 9/20 V, 11/40 S...	98th	...	Left cervical bubo; left sublingual gland enlarged and tender.
244	M	26	5th	5/40 S	...	6th	23 hours in hospital; hopeless at admission. Chinese.
245	M	18	7th	.....	42nd	...	*No serum;* right femoral; slight case; did well from admission.
246	M	46	7th	7/40 S	...	8th	Right cervical; cough, and bright red sputum at first examination, 6th day of illness; bubo not observed till 6th day; declined steadily from admission.
247	M	28	6th	.....	32nd	...	*No serum;* right inguinal.
248	M	17	4th	4/40 S, 6/40 S, 7/40 S, 8/120 S.	...	10th	Septicæmic case.
249	M	38	3rd	.....	42nd	...	*No serum;* supply short; showed no constitutional symptoms except slight feverishness; other severe cases under treatment.
250	F	13	3rd	3/75 S, 4/40 S	68th	...	A severe case.
251	M	23	4th	4/40 S, 5/80 S	...	5th	Right axillary, left axillary slightly enlarged and tender; patient moribund; veins could not be entered.
252	M	74	12th	.....	45th	...	*No serum;* left femoral; practically convalescent on reception.
253	M	6	6th	.....	36th	...	*No serum;* right inguinal; P. 112 the only sign of illness on reception, when appetite very good.
254	F	26	2nd	2/30 S, 3/20 S, 5/20 S.....	30th	...	Left femoral; a mild case.
255	M	55	.....	.....	...	...	*Died before reception.*
256	M	44	15th	/40 S	89th	...	Semi-conscious on reception; left femoral, inguinal; left axillary; right and left cervical also enlarged; Chinese.

Consec. No.	Sex.	Age.	Day of illness on which admitted.	(1) Days of illness on which Serum was injected. (2) Quantity in Cub. Cents. (3) Place of injection (S. = Subcutaneously; V. = Intravenously).	Day after attack on which Patient—		Remarks.
					Was discharged.	Died.	
257	M	33	3rd	3/40 S, and 20 V, 8/40 S	84th	..	Left inguinal; a small carbuncle, abdomen, left side.
258	M	20	3rd	3/40 S, 4/20 V.....	30th	...	Large right cervical bubo.
259	M	9	2nd	1/17 S, 4/40 S	36th	...	Right inguinal; right sterno-mastoid glands also tender.
260	M	7	2nd	2/50 S, 3/20 S	...	3rd	Right axillary, size of small orange; 19 hours in hospital.
261	M	17	3rd	2/40 S, 3/20 V, 4/40 S ...	...	4th	No bubo; carbuncle on back of neck; 21 hours in hospital.
262	M	22	2nd	2/40 S	28th	...	Right axillary and right cervical.
263	M	68	6th	6/40 S	58th	...	Supra-trochlear, right; also right axillary; a slight case.
264	M	27	9th	7/40 S, 9/80 S, 20/40 S ..	60th	...	Right femoral and inguinal.
265	M	25	2nd	2/40 S, and 20 V.....	39th	...	Left inguinal.
266	F	6	2nd	2/55 S, 3/40 S, 4/20 S, 5/60 S, 6/40 S.	...	6th	Right subpectoral.
267	F	44	3rd	3/40 S, and 20 V..	118th	...	Right femoral.
268	M	10	2nd	....	36th	...	*No serum*; left femoral.
269	M	21	3rd	3/40 S	28th	...	Right inguinal; a slight case.
270	M	5	5th	5/20 S	78th	...	Left cervical.
271	M	15	2nd	2/40 S and 40 V	34th	...	Left subpectoral.
272	F	13	6th	6/40 S	40th	...	Left inguinal; very slight case.
273	M	41	8th	8/20 S	22nd	...	Right femoral; ambulant case; hardly ill on reception.
274	M	22	10th	10/40 S	36th	...	Right axillary; a mild case.
275	M	50	.....	4/40 S	...	4th	No bubo; moribund on discovery.
276	M	20	19th	19/40 S	44th	...	Right femoral; convalescent on reception.
277	M	32	5th	5/80 S	30th	...	Left axillary; subsequently gland in right axilla became tender.
278	M	30	8th	.....	33rd	...	*No serum*; left inguinal; very slightly ill on reception.
279	M	13	9th	9/40 S	49th	...	Left femoral; convalescing on reception.
280	M	17	3rd	3/40 S and 20 V, 4/40 S, and 20 V, 6/40 S, 8/40 S, 16/40 S.	46th	...	No enlarged glands; a severe case.
281	M	36	4th	4/40 S, and 40 V	43rd	...	An ambulant case; right femoral bubo.
282	M	19	6th	6/40 S	105th	...	Right femoral; an ambulant case; had not lain up before reception.
283	M	19	5th	5/40 S, and 20 V.....	45th	...	Right femoral.
284	F	65	5th	5/80 S, 6/40 S	...	6th	Left subpectoral.
285	M	33	2nd	2/40 S	26th	...	Right femoral; very slightly ill; had not lain up before reception.
286	M	20	2nd	2/40 S, and 40 V.....	31st	...	Left femoral.
287	M	17	1st	1/40 S, and 40 V, 2/40 S, 10/40 S, 12/40 S.	44th	...	Right inguinal.
288	F	5	2nd	1/35 S	31st	...	Left axillary.
289	M	29	2nd	2/20 S	...	4th	Right femoral; in hospital 11 hours; hopeless when notified.
290	M	18	2nd	2/40 S	38th	...	Left femoral.
291	M	7	8th	8/37 S	35th	...	On reception, both inguinals.
292	M	38	5th	5/40 S, 7/40 S	46th	...	Left femoral; at time of reception stock of serum had become temporarily exhausted.
293	F	38	5th	5/80 S	45th	...	Right femoral.
294	F	2	2nd	1/30 S, 4/20 S	34th	...	Left axillary.
295	M	55	.....	....	...	...	*Died before reception.*
296	F	12	4th	4/20 S, 6/40 S	36th	...	Right cervical.
297	M	42	2nd	2/40 S, 3/40 S	40th	...	Right femoral.
298	M	22	6th	6/40 S and 40 V	33rd	...	Right axillary.
299	M	41	45th	45/60 S	78th	...	Right inguinal; convalescent on reception.
300	M	45	21st	21/60 S, 27/40 S	60th	...	,, ,,
301	M	2	6th	6/20 S	36th	..	Right subpectoral.
302	M	56	5th	5/40 S	...	37th	Right axillary.
303	M	36	7th	7/40 S	58th	...	Left femoral; this case was quite well marked, and approached the severe.

APPENDIX F.

Form 258.

Inoculation against Plague.—Second Series.

Department of Public Health, New South Wales, Sydney, 10 May, 1900.

In view of the expected arrival of a further consignment of plague prophylactic, the Honorable the Premier and Colonial Treasurer has been pleased to approve of the following regulations for its distribution.

J. ASHBURTON THOMPSON,
President of the Board of Health.

Regulations.

1. Preference will be given to persons resident or employed within the infected area.

2. Application must be made by persons desiring to be inoculated at the Town Hall (Druitt-street entrance), between 9 a.m. and midday, on and after a day which will be announced.

3. Applicants will be furnished with a dated ticket entitling them to be inoculated on the date specified thereon.

4. Inoculations will be performed at the Town Hall (Druitt-street entrance) every day except Sunday from 1·30 p.m., until the supply of prophylactic has been exhausted. Two afternoons a week will be reserved for inoculation of women and children.

5. No person unprovided with a ticket will be inoculated. No person provided with a ticket will be inoculated on any but the date specified thereon. Should any holder of a dated ticket allow the appointed day to pass without appearing, a new ticket must be procured before inoculation will be done.

6. Managers of business establishments may furnish lists of their employees by letter, addressed to the Secretary, Department of Public Health, and endorsed "Inoculation." Dated tickets will then be posted to them in return. Employees may be divided by managers into batches, and request made that the different batches may be inoculated on different days.

7. Inoculation is gratuitous and voluntary.

Circular Letter to the Public.

Form No. 256.

Sir, Department of Public Health, N.S.W., Sydney, 1 May, 1900.

A further consignment of plague prophylactic being expected to arrive shortly, I have the honor to inform you that the following arrangement has been made for convenience of those managers of business establishments who may desire inoculation for themselves and their staffs.

2. On receipt of this letter a list of the persons employed at your establishment may be made out by you, and may be forwarded by post to me at the above address. As soon as the prophylactic has arrived you will then receive by post a ticket for each person named in your list, entitling him to inoculation on a date stamped thereon. You may find it convenient to divide your list, so as to avoid absence of your whole staff on one day, and if you do so it will be understood that you desire a different date to be appointed for inoculation of each division.

3. No inoculations will be done at this Department, and the place chosen will be duly announced in the newspapers.

I have, &c.,
C. A. SIMMS,
Secretary.

Letter to Heads of Departments of the Public Service.

Form No. 257.

Sir, Department of Public Health, N.S.W., Sydney, 1 May, 1900.

A fresh consignment of plague prophylactic being expected to arrive shortly, I have the honor, by direction of the President of the Board of Health, to inform you of the arrangements which have been made for inoculation of Civil Servants employed in Sydney.

2. Three methods will be available, and in accordance with regulations which the Premier and Colonial Treasurer has been pleased to make, the number inoculated on any one day will be strictly limited.

(*a*) If you have the goodness to furnish me with a list of the names of officers in your Department who desire to be inoculated, a portion of prophylactic will be forwarded to you sufficient for the number. You may then provide a medical man to make the inoculations, a room in which he can operate, and a clerk to record the names of those operated on, together with the date of operation. This list to be forwarded to me for record with reference to possible occurrence of cases of plague among the persons inoculated at some future date—a matter of great practical importance at this time.

(*b*) You may send a list of the names of members of your staff who desire inoculation to me, when you will receive tickets entitling the holder to be inoculated on a day specified thereon. The names may be divided into batches to be inoculated on different days (so as not to interfere with business unduly). The holders will then present themselves at the place of public inoculation on the appointed day, and will take their turn with the general public.

(*c*) Individuals may make personal application at the place which will be appointed for the issue of tickets, when they will receive dated tickets as last mentioned.

3. Should you decide to adopt either of the methods (*a*) or (*b*), I am to ask you to be good enough to communicate with me at the earliest possible date. It is particularly requested that the names of gentlemen who are habitually employed in Sydney may alone be mentioned, others being in no known danger, and the supply of prophylactic being limited. The place at which tickets will be issued, and the place of public inoculation, will be announced in due course in the newspapers.

I have, &c.,
C. A. SIMMS,
Secretary.

Form No. 268

Department of Public Health, N.S.W.

Sir, Sydney,

In answer to your recent request, I have the honor, by direction of the Chief Medical Officer of the Government, to forward you herewith doses of Haffkine's plague prophylactic, and to call your attention to the instructions and conditions mentioned hereunder.

As a matter of convenience the form referred to, which will be found overleaf, is perforated, so that it may, when filled up with the particulars, be torn off and returned to me.

I have, &c.,
C. A. SIMMS,
Secretary.

To Dr. ———

Haffkine's

Haffkine's Prophylactic.

The prophylactic is issued to medical practitioners on condition that they forward to the Secretary of this Department, as soon as possible, particulars concerning ages, addresses, and doses administered, &c., by them, in accordance with subjoined form :—

Dosage.

For a male aged 25 years or over ... ... 5cc.
" " " 20 " " ... ... 4cc.
" " " 15 " " ... ... 3cc.
" " " 10 " " ... ... 2cc.
" " " 5 " " ... ... 1cc.

Intermediate ages, intermediate doses. Females to receive one-fifth less than males of same age.

NOTE.—It is not safe to use the prophylactic save within an hour or two after the bottle has been opened. Arrangements should be made for the attendance at the same time of a sufficient number of people to use up the whole bottle.

Schedule.

PARTICULARS of Persons inoculated with Haffkine's Prophylactic.

Date of Inoculation.	Name.	Age.	Address.	Dose.

(Signed)

(Address)

The Secretary, Department of Public Health, Sydney.

APPENDIX G.

Cleansed Areas.

TABLE showing the dates on which Cases were infected within the several Areas which were specially cleansed, before, during, and after completion of cleansing : together with the dates on which each area was closed for cleansing. The dates of release are often merely formal ; areas seldom remained closed more than seven or eight days, and often less. (*See* Diagrams A, B, and C.)

	Case No.	Date.		Case No.	Date.
		1900.			1900.
Area 1.—Subdivision 1	5	March 1	Area 2.—Subdivisions 1 and 2	56	March 30
	11	" 5		70	April 1
	14	" 10		Closed ...	" 2
	10	" 13		Released	" 6
	21	" 14	Subdivision 3	9	March 7
	24	" 18		67	" 31
	25	" 18		Closed ...	April 2
	26	" 15		83	" 5
	32	" 20		84	" 5
	Closed ...	" 23		85	" 5
	37	" 25		Released	" 10
	Released	" 31	Subdivisions 4 and 5	Closed ...	" 2
	104	April 4	Subdivision 4	Released	" 12
	165	" 30	Subdivision 5	"	May 22
Subdivision 2	2	Feb. 18	Subdivision 6	49	March 26
	Closed ...	March 23		55	" 28
	39	" 25		58	" 26
	Released	April 3		64	" 29
				65	" 29
Subdivision 3	Closed ...	March 23		66	" 29
	Released	May 22		Closed ...	April 2
				Released	June 4
Subdivision 4	10	March 7	Area 3.—Subdivision 1	29	March 20
	Closed ...	" 23		Closed ..	April 9
	97	April 6		Released	" 12
	103	" 10	Subdivision 2	27	March 17
	Released	May 22		Closed ...	April 9
Subdivisions 5 and 6	Closed ...	March 23		Released	May 22
Subdivision 5	Released	May 22	Subdivision 3	Closed ...	April 9
Subdivision 6	"	" 22		Released	June 27

	Case No.	Date.
		1900.
Area 4	Closed ...	April 9
	Released	,, 20
Area 5.—Subdivision 1	53	March 29
	100	April 6
	Closed ...	,, 12
	140	,, 19
	Released	,, 20
Subdivision 2	52	March 25
	75	April 2
	86	,, 5
	107	,, 12
	Closed ...	,, 12
	Released	,, 24
	189	May 3
	223	,, 10
	255	,, 31
	285	June 22
Area 6	Closed ...	April 20
	Released	,, 24
Area 7	8	March 6
	110	April 10
	Closed ...	,, 20
	173	,, 25
	Released	May 1
Area 8	61	March 29
	62	,, 31
	Closed ...	April 24
	Released	May 25
Area 9	34	March 21
	183	April 25
	Closed ...	,, 27
	Released	May 1
Area 10	89	April 7
	Closed ..	,, 30
	Released	May 15
	290	June 24
Areas 11 and 12	Closed ...	May 1
	Released	,, 15
Area 13	57	March 26
	Closed ...	May 2
	Released	,, 15
Area 14 (Redfern)	23	March 17
	59	,, 30
	77	April 5
	80	,, 3
	134	,, 21
	159	,, 23
	177	,, 29
	Closed ...	May 3
	Released	,, 15
Areas 15 and 16	Closed ...	May 5
	Released	,, 15
Area 17	Closed ...	,, 7
	224	,, 9
	Released	,, 22
Area 18	129	April 20
	Closed ...	May 15
	245	,, 17
	Released	June 1
	297	,, 29
Area 19	72	March 31
	Closed ...	May 15
	Released	June 1
Areas 20 and 21	Closed ...	May 15
	Released	June 1
Area 22	4	Feb. 26
	Closed ...	May 15
	Released	June 1
	303	August 2
Area 23	Closed ...	May 15
	Released	June 1

	Case No.	Date.
		1900.
Area 24	234	May 11
	Closed ...	June 1
	Released	July 3
Area 25	230	May 14
	258	,, 29
	Closed ...	June 1
	Released	,, 15
Area 26	Nil.	Nil.
Area 27 (Paddington)	76	April 4
	121	,, 16
	151	,, 21
	154	,, 25
	167	,, 23
	208	May 8
	Closed ...	June 7
	Released	July 3
Area 28 (Paddington)	Closed ...	June 7
	283	,, 17
	284	,, 18
	Released	July 3
Area 29	233	May 13
	Closed ...	June 15
	295	,, 26
	Released	July 10
Area 30	127	April 20
	231	May 13
	Closed ...	June 15
	Released	July 10
Area 31	212	May 11
	Closed ...	June 15
	Released	July 10
Area 32	94	April 6
	123	,, 18
	176	,, 26
	Closed ...	June 15
	Released	July 10
Area 33	116	April 11
	136	,, 22
	172	,, 30
	Closed ...	June 15
	Released	July 10
Area 34 (Waterloo)	161	April 28
	162	,, 28
	170	May 2
	237	,, 10
	Closed ...	June 15
	Released	July 10
Area 35	190	May 1
	266	June 3
	Closed ...	,, 15
	Released	July 10
Area 36	35	March 25
	111	April 11
	160	,, 26
	235	May 13
	254	,, 29
	263	,, 28
	Closed ...	July 17
	Released	August 5
Area 1 (Manly)	175	May 2
	213	,, 11
	217	,, 13
	242	,, 21
	253	,, 29
	257	June 1
	Closed ...	,, 4
	288	,, 25
	Released	July 3
Areas 2 and 3 (Manly)	Closed ...	June 26
	298	July 12
	Released	,, 13
Areas 5 and 6 (Manly)	Closed ...	,, 10
	Released	,, 13

APPENDIX H.

Text of the Poster and Pamphlet issued on March 1st, 1900.

Department of Public Health, New South Wales.

Prevention of Plague.

PLAGUE is present in Sydney. It has been introduced by diseased rats, and there is great danger of its spreading still further.

Great efforts must therefore be at once made by Municipal Councils and by individual householders to kill all rats. This war must be persistently and steadily carried on. It must extend to every neighbourhood, as well as to those where the rats are known to be infected, for the following reason :—As soon as rats find they are dying in numbers, or are being trapped and killed, in any place they inhabit, they leave that place and go to some other. If there are already rats at the latter place, these become infected by the immigrants, and then disperse in their turn, thus carrying the disease still further. All rats, therefore, must be exterminated as far possible, and the attack upon them should be simultaneous in the healthy and infected neighbourhoods.

The following hints should be carefully read :—

1. It is most necessary that rats should be kept out of dwellings. Take care that doors are not broken near the ground, and close them at night ; see that all gullies are effectually trapped ; see that every house connected with the sewers is so connected according to the Regulations of the Board of Water Supply and Sewerage, and that the traps are in good order, so that rats cannot get past them.

2. Gather up with scrupulous care all fragments of food, bones, vegetables, potato-peelings, corn, &c., &c., and either burn them at once behind the kitchen fire, or place them in a securely covered dirtbox ; as far as possible also leave no water about where rats can get at it. Rats are always looking for food, and will not stay where none is to be found.

3. Lastly, take measures to kill any rats which happen to reach the premises. Poison is the best means, and nothing is better than arsenic, which is sold as "Rough on Rats," and under other names. It should never be spread on bread and butter, which might attract children, nor on any similar food. It should be mixed with a little meal and water. Oil of aniseed and an oil called oil of rhodium are said to be specially attractive to rats, and a little may be mixed with the meal, or smeared on traps. Set traps also. Use dogs too ; dogs very rarely indeed have suffered from plague, and, at all events, it is not only diseased rats which are to be destroyed, but also healthy ones.

Dead rats found about premises should not be touched until they have first been scalded with boiling-water where they lie ; they should then not be taken up in the hands but with tongs ; they should be burnt.

Extermination of rats is the most important thing to be attempted at this time. Very good reason has been shown for thinking that the plague spread in Indian cities not so much in proportion to overcrowding nor to filth as in proportion to the facilities which houses afforded by their construction for entrance of rats to dwelling-rooms.

Still, it must be remembered that, although rats may begin an epidemic of plague in man, they are by no means the only carriers of the contagion. Plague is a fever ; like other fevers, it is aided in its attacks by filthy surroundings, and probably its infection is fostered by filthy heaps of neglected and putrefying material, and by filthy earth.

Very great and special pains must therefore be taken by householders to thoroughly cleanse their houses internally, their yards, their gutters, and their drains. Municipal authorities should increase their staff of scavengers, and take care that all the minor nuisances (which at present are subject of daily complaint to this Department) are abated forthwith, and prevented from recurring ; they should also regularly collect and destroy filth, sweep and flush road and other gutters under their control, and take care that sewers within their jurisdiction are often flushed. Municipal authorities are seldom provided with large staffs, and nuisances sometimes exist for long before they are detected and dealt with. Every ratepayer should make a point, therefore, of reporting every nuisance which he observes in his district to the Council Clerk, who represents the Council, which latter is the Local Authority under the Public Health Act for the district it serves. It has full legal power to deal with and prevent all nuisances, either by its own action or through the Police Courts. Such complaints should not be addressed to this Department, which cannot execute detail work over the whole Colony. Detail work is the duty of Local Authorities within their several districts or municipalities.

Directions for Special Cleansing and Disinfecting.

Limewash all ceilings and whitened walls afresh ; limewash all cellar, basement, and outhouse walls.

Swab all woodwork thoroughly with carbolic water—include sash frames, window cases, &c.

Remove all floor coverings ; have carpets beaten ; oilcloth, &c., to be washed with carbolic water on both sides. Scrub the floors if of boards, and swab with carbolic water. Water stone, brick, and earth floorings with carbolic water three times a week.

All lumber and the like not in actual use must be removed from the premises and not returned to them. All wastes, garbage, ashes, dung, stable bedding, &c., &c., must be removed, and stable bedding renewed with clean stuff.

Stable floors, if of wood, or likely to be foul beneath, must be torn up, the surface below thoroughly cleansed as described, and replaced with good floors properly close-jointed and caulked, well-bedded on a sound bottom, and graded to a gutter. The gutter must be placed in communication with a gulley leading to the sewer.

All drains, gullies, sinks, water-closets must first be flushed with hot water. They must then be flushed with carbolic water, and afterwards be kept dressed with chloride of lime.

Furniture must be moved so as to give access to walls for cleansing, &c., and to the floor on which it has been standing.

All

All makeshift buildings and and sheds in bad repair must be pulled down and removed before the premises can be considered clean.

Solid disinfectant—Chloride of lime.
Liquid disinfectants—Carbolic water—Miscible carbolic, ¾ pint; water, 1 gallon.
Carbolic limewhite—Miscible carbolic, ½ pint to the gallon.

For household use, chloride of lime, mixed with water in the proportion of half a pound to the gallon, may be used for all purposes within and outside; or carbolic acid and the well-known tarry disinfectants, suitably diluted according to instructions with which they are sold. The poorer inhabitants should be supplied by the Local Authority for the district (the Municipal Council) free of cost, and Sanitary Inspectors should see that the disinfectant is properly applied.

The fullest information as to disinfection and disinfectants has been printed in a pamphlet, containing Suggestions for the prevention of the Infectious Diseases proclaimed under the Public Health Act, of which large numbers of copies have been sent to each Local Authority over the whole country. This was done more than a year ago. Any ratepayer can get one by application at the Council Chambers in his district.

By order,
C. A. SIMMS,
Secretary.

Sydney, 1st March, 1900.

*** Local Authorities will be supplied gratis with the disinfectants called miscible carbolic acid, cresylene, and chloride of lime, on application to the Chief Inspector of Stores, Young-street, Sydney; but of the two first named one only will be furnished.

APPENDIX I.

Form No. 251.

Department of Public Health, New South Wales.

Prevention of Plague.

Notice to Shipmasters, Agents, and Owners touching fumigation and destruction of rats.

ALL vessels trading between Sydney and every other port or place in New South Wales having to be fumigated under the Proclamation No. 286 of Friday, 30th March, 1900, in accordance with the requirements of the Board of Health, and having to produce a certificate that such fumigation has been so done to the Customs Officer at the ports or places at which they touch before communication with the shore will be permitted them, the following suggestions are published with a view to prevent loss of time in performing fumigation:—

1. Masters are expected to assist the officers of the Board in every way.
2. Preparation for fumigation should be made by the Masters as follows:—Compartments to be carefully examined and all openings closed, except one for access, as well as all cracks and crevices, A bucket of paste and a bundle of old newspapers are all that is required besides the usual closings, hatches, &c., &c.
3. As soon as these preparations are complete or well under way, notice must be given to Captain Tait, Superintendent of Fumigation, at the Customs House, Circular Quay, stating where the vessel is lying, and when she will be ready for fumigation to begin. The Superintendent will supply forms on application.
4. The actual fumigation must be done by or under immediate superintendence of the appointed officers of the Board.
5. After completion of fumigation to the satisfaction of the Superintendent, a certificate will be given in the appointed form, stating that fumigation has been done, and that the certificate is good until the date mentioned therein, when it will expire, and when fumigation must be repeated.

By Order,
C. A. SIMMS,
Secretary.

Sydney, 30 March, 1900.

Form 243.

Certificate of Fumigation delivered to Master by Superintendent.

Department of Public Health, New South Wales.

THIS is to certify that the vessel Master, tons register, was fumigated at this port for the purpose of destroying rats on board, under supervision of an officer of this Department, on this day of 1900.

C. A. SIMMS,
Secretary.

Signed, Superintendent.

1900.

NOTE.—This certificate is incomplete and of no avail unless countersigned by the Superintending Officer

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APPENDIX K.

APPENDIX K.

Governor's Regulations under the "Wharfage and Tonnage Rates Act of 1880."

1. Every vessel lying at a public wharf at any port or place in New South Wales must be maintained by fenders at a distance of not less than 4 feet from the wharf.

2. The fenders used, as required by the last preceding Regulation, together with any ropes attached to them must be freshly tarred each time before use, and daily if continuously used for more than twenty-four hours.

3. To each hawser and rope by which the vessel is made fast for 6 feet of length from the shore end, and for 6 feet in length from the ship end, and to fore and aft springs throughout their whole length, tar must be applied so that the said parts and springs are thoroughly covered, freshly before each time of use and daily if continuously used for more than twenty-four hours. The tar may be applied by means of bagging securely fastened around the hawser, rope, or spring.

4. All gangways must be drawn up, except when in actual use, for reception of cargo, except a single passenger gangway, and the said passenger gangway while in use must be constantly maintained freshly tarred on its upper surface for a distance of 3 feet at least from its shore end, and for a distance of 3 feet at least from its ship end.

5. Between sunset and sunrise, lamps of the best available sort must be suspended over the side sufficient to keep the wharf fore and aft brightly lighted.

6. All port and other holes in the ship's side next the wharf must be kept closed, unless in actual use for reception of cargo, when they must be brightly lighted as long as the vessel lies at the wharf.

7. No net must be used between the ship and the wharf.

8. No lighter must be allowed alongside except by special written permission of the Manager of Public Wharves.

9. Every master of a vessel who contravenes any of these Regulations shall be liable to a penalty not exceeding £20, and not less than £5, which may be recovered in a summary way before a Police or Stipendiary Magistrate, or any two Justices of the Peace, in accordance with the Acts relating to proceedings before Justices of the Peace, adopted by the Act 14 Vic. No. 43, and any Acts amending the same.

APPENDIX L.

Report of the Board of Health upon the Case of A.P.

The Chief Medical Officer of the Government and President of the Board of Health to The Honorable the Premier and Colonial Treasurer.

February 7, 1900.

* * * * * * * * * * *

I.—Clinical Account.

A.P., aged 33, married, a rather slight but muscular man, fair, and of nervous temperament; had had no illness for several years past. On *January 19th* he was driving a lorry through the city about 12 o'clock, on a very hot day, when he was suddenly seized with giddiness, headache at the vertex, and pain in the region of the stomach; he was obliged to lie down for a time when he reached the warehouse to which he was then going, but afterwards finished his day's work, though still suffering. About four hours after attack he began to feel pain in the left thigh near the groin, and discovered a small lump which had not been there before. He left work at 6 o'clock and went to bed; he took some castor oil, and had free action of the bowels; he also vomited, the vomit being of natural appearance. He was very ill all night with headache, thirst, fever, and continued pain in the gastric region; the lump in the thigh ached continuously. *January 20th*, at 2·15 p.m., he was found dozing, but was easily roused to attention; his face was flushed, and a little puffy or heavy-looking; his eyes were slightly suffused; the skin felt burning hot, the axillary temperature was 104·9° F., and the pulse was rapid and bounding. Examination of the lungs discovered no sign of disease; he was able to move about the bed freely, and to show various parts of his body readily; he answered questions promptly and clearly; there was no delirium, nor anxiety, nor interference with speech; the spleen could not be felt. The left lower extremity showed the lowest gland of the femoral chain enlarged; it was just visible, was about the size of an unshelled almond, indurated, and but slightly tender on pressure; the swelling was well defined, and limited to the gland itself, there being no infiltration of the surrounding tissues; two other glands, which seemed not to be enlarged, could be distinguished just above it. There was no inguinal enlargement, and careful examination of the rest of the body failed to discover any other swollen ganglion, except one in the right submaxillary region; this was hard, was not tender, and, though the patient was unaware of it, was probably old. The genital organs were perfectly free from lesions of any kind, and there were no signs of venereal disease present or past. The leg was examined for injuries which might have given rise to swelling of the gland, but none were found. A further examination, made two days later, disclosed the following:—Behind the left external malleolus, and just anterior to the edge of the achilles tendon, was a circular spot, about 3 mm. in diameter; the cutis was purplish red; the cuticle which had been detached was then adherent to the skin; at one point of the circumference it was slightly ragged. It seemed probable that this had been a bleb; its circular form and protected position suggested that it had not been produced by abrasion; and, while the feet showed no evidence of chafing at any other point, the patient said he had been wearing the same boots for three or four months past, and that they had never hurt him. Three days afterwards the cutis had lost its reddish-purple colour, and new cuticle had been formed. Earlier observers felt unable to say that this lesion had not been present at the first examination.

On *January 21st* his temperature had fallen to 102·2° F.; the pulse was no longer bounding, and was occasionally intermittent (imperfect systole); he still had some headache at the vertex, but he had slept tolerably well, and was better. The gland formed a visible lump of the size of a walnut; the skin

over

over it was slightly red, but it had been continuously fomented with hot boracic lotion; there was commencing peri-adenitic effusion, but no matting with the smaller glands immediately above could be made out. On *January 22nd* his temperature about midday had fallen to 99·2° F.; he was cheerful and alert, but pale and rather tremulous; the headache was less; he felt weak, but not exhausted; the gland had markedly increased in superficies, but was not much thickened, and though still quite tender was not at all acutely sensitive. He had slept well. On *January 23rd* the patient was in a similar state, but decidedly thinner and paler than at first; his temperature had risen again to 102·4° F.; the pulse was weak and easily compressed, but not intermittent. The femoral swelling had increased, and was nearly circular, about 2 inches in diameter. On *January 24th* his temperature was still 102·4° F., and his general state about the same; the femoral gland was of the size of a mandarin orange; it was still hard, surrounded with effusion, only moderately tender, and free from fluctuation.

2.—Bacteriological Investigation.

The bacteriology of this case was described by Dr. Frank Tidswell in the following report:—

On January 21st a puncture of the gland was made with instruments just previously sterilised by exposure to steam for half an hour in the Koch steriliser. The cotton-wool wrappings were retained till the time of operation, and the instruments were still warm when used. The part had been continuously treated with boracic acid fomentations for the previous twenty-four hours. Just prior to the operation the skin was shaved, well washed with 5 per cent. carbolic lotion, then with recently boiled and still warm distilled water, and finally dried with sterilised cotton wool. Through the single opening in the skin by partial withdrawal the syringe needle was passed in six different directions through the gland. The piston was raised on each occasion, but no fluid entered the barrel of the syringe. On its final removal the channel of the needle was found to contain a minute quantity of blood. This was ejected over the surface of a serum culture tube brought for the purpose, and a second serum culture tube was inoculated from the first in the ordinary way by means of the platinum needle. Both of these tubes incubated at 37° C. remained sterile for a period of ten days, when their further observation was abandoned.

On January 22nd, whilst palpating the gland, a drop of pus-like fluid was expressed through the puncture hole of the previous day. On the 23rd and 24th also similar fluid was obtained in the same way. On each occasion the single drop issuing was used to make smear preparations, and cultivations on serum and agar; and that obtained on the 22nd was also used to inoculate a mouse. As the microscopical and cultural characters of the three samples of fluid were identical, one description will serve for all.

The fluid expressed was of a dark greyish colour, showing a little red (blood), but no yellow. A small portion set aside was found to have clotted firmly when examined half an hour afterwards. The amount of blood present was far too small to account for this clotting, and, moreover, the clot was pale in colour. It is evident, therefore, that the fluid contained a large admixture of lymph. Under the microscope the fluid was seen to contain numerous lymph cells. A few were normal in character, but most of them showed fragmented nuclei, and more or less granular cytoplasm, *i.e.*, resembled "pus cells." Lying in groups and singly amongst the cells were numerous bacilli, varying, but commonly ovoid or cylindrical in form, ranging between 1μ and 3μ in length and about ·5μ broad; ends tapering and finally rounded off; staining well with gentian violet, fuchsine, or methylene blue, and more densely at the poles than in the middle of the rods. The majority did not retain the stain when treated by Gram's method, although here and there an individual bacillus remained coloured. No spores were seen. Rounded bacterial elements were not uncommon, and the results of cultivation subsequently showed them to be micrococci, and not merely cocco bacilli.

The cultivations were upon ordinary serum and upon nutrient agar, the inoculations being made at the bedside with the platinum needle sterilised in the flame of a spirit-lamp. The tubes, inoculated about noon, showed definite growth on the second morning afterwards, *i.e.*, in about forty-five hours, having been incubated at 37° C. in the interval. The growths were of two kinds, one composed of micrococci, the other of bacilli.

The micrococcal growth upon serum developed in the form of rounded colonies, attaining a diameter of ·5 mm. in forty-eight hours, and extending to 2 or 3 mm. in three or four days. Thick, opaque, flat, slightly irregular margins, smooth surface, creamy white in colour. In subculture the growth was more rapid at first, a 1 mm. wide creamy streak developing in twenty-four hours. After this the growth extended slowly, reaching a width of about 3 mm. after five days at 37° C. No alteration in colour was observed. There was a thick deposit and turbidity in the condensation water. Upon nutrient agar the growth was similar to that on serum, but whiter. On glucose agar the growth was more abundant than on nutrient agar, and was well up in twenty-four hours. In bouillon there was uniform turbidity already apparent in twenty-four hours.

The cocci stained readily with gentian violet, fuchsine or methylene blue, and retained the colour when treated by Gram's method. Under the microscope they were seen to be regular in outline, and to lie singly or in groups (staphylo cocci). There were no chains. Individual cocci measured ·5 to ·8 μ. in diameter. The transverse line commonly seen in the pyogenic cocci was not detected in any of the specimens examined.

The bacilliary growth upon serum at 37° C. was scanty. It appeared in forty-eight hours in the form of small, round, slightly raised translucent colonies, of a little less than ·5 mm. in diameter. The growth had not extended much by the third day, after which, in the original tubes, it became overgrown by more rapidly developing micrococci. In subculture upon serum the growth was visible as a thin colourless streak, in forty-eight hours it increased to a band about a millimetre wide. After five days it formed a thin translucent streak still limited to the neighbourhood of the inoculation line, slightly thicker at the margins with outlying colonies, and showing granular raised specks at irregular intervals. Upon nutrient agar and glucose the growth was very similar, and when looked at from the back had a ground-glass appearance. In broth it formed abundant spicular or crumb-like particles attached to the side of the tube, with an obvious deposit of same character as that in Haffkine's prophylactic, the broth itself remaining perfectly clear and transparent. A filmy appearance on the surface disappeared on shaking, and was not reformed after four days at 37° C. In flasks with oil a film and a few pendent growths 2 to 6 mm. long were formed, as well as a copious deposit.

The bacillus stained readily with violet, fuchsine, or methylene blue. Is decolourised by Gram's method, although here and there individual bacilli or small groups of them retain the colour. Non-mobile, at least as regards obvious movements of translation. The bacillus shows very distinct bipolar staining, more marked in some specimens than in others, but clearly recognisable in all. This characteristic may amount to the colouration of only a polar granule, or to colouration of most of the bacillus, leaving only the middle of the rod unstained. Intermediate gradations are common. The bacillus varies very much in form, regularly cylindrical, boat-shaped, club-shaped, dumb-bell, and oval elements are the commonest forms. The length varies between 1 μ and 3 μ, and the breadth is usually about ·5 μ. The ends are rounded off. No spores were observed.

Some of the material obtained from the femoral swelling on 22nd January was inoculated at 4·30 p.m. into a mouse—into the back at the root of the tail. The animal was lively during all the next day. There was no visible swelling at the site of inoculation; but the mouse was not handled. Next day it was much less lively in the morning, and got very sick during the afternoon. At 6 p.m. it was huddled up, coat rough, respiration hurried, refusing food, but started up when the glass of its jar was flicked. It was found dead and stiff next morning at 9 a.m., having thus become definitely sick within forty-eight hours, and died within sixty-four hours after inoculation.

The principal *post-mortem* features were as follows: Hæmorrhagic œdema at site of inoculation; enlargement of the inguino-femoral glands on the right side; no enlargement of glands detected elsewhere; pericardium dusky, but no hæmorrhages seen; both ventricles of the heart distended with feebly clotted blood; lungs bright red in colour, patchy pneumonia (?); liver definitely but not very much swollen, mottled white and pink on surface; deep red on section; gall bladder empty, or nearly so; spleen not much, if at all, longer than normal, but thicker, swollen in such a way as to lose its normal sharp edges and assume a sausage-shaped form, section deep red, trabeculæ could not be seen with a hand lens; stomach normal, small intestine congested, large intestines not obviously affected, but contain fluid fæces; kidneys mottled, ection pale, internal structure obscure; bladder distended with urine of normal colour. Smear preparations and cultures made from various organs gave the bacilli showing bipolar staining.

A second mouse, inoculated with a small piece of the spleen of mouse 1 on 25th January, at 10·30 p.m., was lively on the following day (26th). On the 27th it became sick, exhibiting the same symptoms as the first mouse. On the 28th, at 9 a.m., it was lying partly upon its left side—the hind quarters being in a normal position; but the forelegs were tucked away, the left shoulder touching the wire-gauge floor of the cage, and the head stretched out. It remained quiescent in this position till it died at 11 o'clock. The second mouse thus became sick in about forty-eight hours, and died in seventy-two and a half hours after inoculation.

The principal *post-mortem* features were as follows, the animal being examined ten minutes after death: Hæmorrhagic œdema at the site of inoculation; enlargement of hæmorrhagic infiltiation round the right inguino-femoral glands; enlargement of the left inguino-femoral, and right and left axillary glands, but no hæmorrhage. Pericardium dusky, but no hæmorrhages; right ventricle of heart contains fluid blood, left ventricle contracted and empty; lungs redder than normal, but not so much affected as in first mouse; liver slightly swollen, mottled pink and white on surface, section deep red; gall bladder distended with clear yellow bile; spleen not visibly altered internally, but section a little thicker than normal, and of a deep red colour; trebeculæ faintly discernible with lens; stomach normal, small intestines markedly congested, large intestine contains fluid fæces; kidneys normal on surface; section pale; structure obscure; bladder empty. Smear preparations and cultures were made from various organs gave bacilli as in first mouse.

A third mouse, inoculated on 28th instant with a small piece of the spleen of mouse No. 2, became sick on the 30th instant. During 31st January and 2nd February it had a series of seizures, characterised by very hurried and laboured breathing and prostration, and on each occasion appeared about to die. In the intervals it sat quietly huddled up, rarely moving, and taking very little food. It was found dead at 9 a.m. on the morning of 2nd February, having thus become sick on the second day, and died in about four and a half days. The *post-mortem* appearances were very similar to those shown by the other mice; in particular, the left inguino-femoral glands were swollen and surrounded by hæmorrhagic œdema, and the spleen enlarged to twice its normal size.

A guinea-pig, inoculated in left thigh on 25th January with a small piece of the spleen of mouse 1, showed no sign of illness till the 27th, but upon that day became quiet and drowsy, and took food sparingly. On the 28th it became very obviously sick, sitting huddled up with the back arched, eyes partly closed, and rarely moving. On the 29th and 30th it remained in very much the same condition, and was found dead at 9 a.m. on the 31st instant. The principal *post-mortem* features were as follow:—Hæmorrhagic infiltration at site of inoculation and in left inguino-femoral region; right groin normal; enlargement of and hæmorrhage round left axillary glands; right axillary glands enlarged; heart shows subpericardial hæmorrhages along auriculo-ventricular and interventricular grooves, and also along the edge of the right ventricle; lungs dark in colour, especially upper and middle right lobes, in which there is broncho-pneumonic consolidation; subpleural hæmorrhages in various places in all lobes; liver enlarged to about twice normal size, mottled red and white on surface, numerous small subcapsular hæmorrhages; spleen about three times larger than normal, deep violet in colour, showing very numerous white areas on both sides resembling miliary tubercle in appearance, edges rounded, no hæmorrhages; kidneys not enlarged, dusky in colour, hæmorrhages under capsule; suprarenals, especially left, enlarged and hæmorrhagic; bladder distended with clear urine giving albumin ring with nitric acid. No definitely abnormal appearances were detected in stomach or intestines. The blood-vessels found on reflecting the skin were markedly injected, and the blood fluid. The viscera were not sliced as it was desired to preserve the specimen with the organs *in situ*, for microscopical and cultivation purposes small pieces were obtained through areas on the under parts of the organs, previously seared in the usual way with a hot knife-blade. The smear preparations and cultures showed the bacilli already described.

A second guinea-pig, inoculated on 30th January with a small piece of the spleen of guinea-pig No. 1, became sick on 29th January, was very sick during 31st January and 2nd February, and died at 1·30 p.m. on 2nd February, having thus become sick in two days, and died in about four days. The *post-mortem* appearances were similar to those of guinea-pig No. 1, except that the spleen, though twice the normal size, did not show the miliary-tubercle-like appearance.

From the foregoing description of the bacteriological examination of material obtained from the enlarged femoral gland of A.P., it will be seen that two microbes were isolated—(*a*) a micrococcus still undetermined, but most likely one of the varieties of staphylococcus pyogenes albus; and (*b*) a bacillus answering positively to all the immediately applicable tests for *Bacillus Pestis Bubonicæ*.

FRANK TIDSWELL.

3.—Epidemiological Relations.

A.P. was a lorry-driver, employed by the Central Wharf Company. His chief occupation was carting exports from city warehouses to the wharf, and delivering them either at his employer's warehouse or at the ship's side. For several months past he had been thus engaged in carting wool almost exclusively. Occasionally he used a truck to run goods from the warehouse across the wharf. He had not handled goods discharged from any ship since the previous August. He had no business on board ships, though he may occasionally have carried a message to the mates; and he had not been below on any ship for three months past at all events. Since Christmas he had only visited one other wharf, that of the A.U.S.N. Co., on January 9th, when he removed green hides imported from Queensland to a city warehouse. Both steam and sailing vessels from plague-infected ports must by this time (namely, near the end of the sixth year from the date of declaration of the epidemic at Hongkong) have discharged or loaded at every suitable wharf in the harbour; and, as regards Central Wharf alone, between November 1st and January 20th four steamships, which all carried Chinese crews, and which had all touched at Hongkong, had lain there—one of them from January 9th to 20th.

4.—Local Conditions.

A.P. had lived in the house where he was found for eight years (see illustration). It was built of brick, on a sandstone ridge, which sloped rather steeply to a branch of the harbour, within the city limits, and in a neighbourhood containing many large warehouses. It had two stories, four rooms, a small attic, and an unused basement, of which the natural rock formed the floor. It was in average general repair, but the sewerage was seriously defective.* There were no inside fittings, but there was a yard gulley halfway down the small walled yard, and a water-closet at the end of it. These were drained by 6-inch glazed E.W.P., which ran forward under the house in a chase cut in the rock floor of the basement. The drain was in aërial connection with the sewer, and the last length of piping against the front wall of the house had had a considerable hole knocked in it; the interior of the dwelling was thus brought into direct connection with the interior of the sewer. On the other hand, however, the basement had a large opening at pavement level in its front wall, and a door at the back, both of which were said to be kept constantly open. The drain junctioned with a very old oviform rubble sewer, which discharged on the foreshore at Dalton's Wharf, about 50 feet below the house and about 150 yards away, next to the Central, and which was unprovided with any tide-flap. Very few houses were connected with it, and its chief use seemed to be discharge of storm-waters. In every domestic respect the house was tidy, clean, and well-kept.

J. ASHBURTON THOMPSON.

* This is too generally the case within the city of Sydney, which in this respect is very sharply distinguished from the rest of the Metropolitan area. In the latter sewerage is under exclusive control of the Metropolitan Board of Water Supply and Sewerage; and the 38,000 houses, containing 182,000 persons, to which the Board's service had been extended down to December 31st, 1899, are in every case connected on the most approved principles.

APPENDIX N.

Circular. Form No. 236.

Department of Public Health, New South Wales, Sydney, 8 February, 1900.

Bubonic Plague.

Sir,

I do myself the honor to draw your attention to the enclosed copy of *Supplementary Government Gazette* of the 6th instant, No. 108, in which Plague is proclaimed to be a notifiable disease under the Public Health Act, Part III, in accordance with Section 20 thereof.

2. In connection with this proclamation, I would point out that, whereas notification of the commoner infectious diseases is properly not required until the diagnosis has become clear [see Public Health Act, Section 21 (b)], it is desirable in the general public interest that a somewhat different course should be taken with Plague. Success in the prevention of this disease depends so largely on early knowledge of all cases which occur that, although it is not the law, I venture to urge upon you the desirability of notifying not only declared cases, but also those in which the clinical symptoms, the patient's occupations, his recent movements, &c., &c., furnish ground for reasonable suspicion of plague.

I have, &c.,

J. ASHBURTON THOMPSON,

Chief Medical Officer of the Government.

APPENDIX O.

Department of Public Health, N.S.W. Form 247.

Directions for Special Cleansing and Disinfecting, issued to the Staff of Sanitary Inspectors, Scavengers, &c.

Limewash ceilings whenever dirty, and in all small property; spare good ceilings in good condition or decorated, &c., &c.

Limewash all whitened walls afresh; limewash all cellar, basement, and outhouse walls.

Swab all woodwork thoroughly with carbolic water—include sash frames, window cases, &c.

Remove all floor coverings; have carpets beaten; oilcloth, &c., to be washed with carbolic water on both sides. Scrub the floors if of boards, and swab with carbolic water. Thoroughly saturate inside stone and brick floorings with carbolic water.

Saturate all outside pavements and soil with sulphuric acid water.

All lumber and the like not in actual use must be removed from the premises and not returned to them. All wastes, garbage, ashes, dung, stable bedding, &c., &c., must be removed, and stable bedding renewed with clean stuff.

Stable floors, if of wood, or likely to be foul beneath, must be torn up, the surface below thoroughly cleansed as described, and replaced with good floors properly close-jointed and caulked, well-bedded on a sound bottom, and graded to a gutter. The gutter must be placed in communication with a gulley leading to the sewer.

All drains, gullies, sinks, water-closets must be first flushed with hot water. They must then be flushed with carbolic water, and afterwards be kept dressed with chloride of lime.

In warehouses, &c., merchandise (except heavy machinery) must be moved so as to give access to walls for cleansing, &c., and to the floor on which it has been standing.

All makeshift buildings and sheds in bad repair will be condemned, and must be pulled down and removed before the premises can be passed as clean.

Occupants of premises which have been passed as clean will be furnished with a small placard, which they may affix in a conspicuous position, stating that the premises have been cleansed in accordance with the requirements of the Board.

Solid Disinfectant.—Chloride of lime.

Liquid Disinfectants.—Carbolic water—Miscible carbolic, ¾ pint. Water, 1 gallon.

Sulphuric acid water.—Sulphuric acid, ½ pint. Water, 1 gallon.

Carbolic limewhite.—Miscible carbolic, ½ pint to the gallon.

By Order,

C. A. SIMMS,

Secretary.

Department of Public Health, New South Wales. Form No. 246.

These premises have been cleansed and disinfected, in accordance with the requirements of the Board.

C. A. SIMMS,

Secretary.

Address of premises, Date,

Signed, Sanitary Inspector in Charge.

No

No. . Department of Public Health. Form 250.

Notice to Cleanse and Disinfect, under the Public Health Act.

To occupier of situated at No. street.

The Board of Health, being of opinion that it is necessary that the premises occupied by you should be cleansed and disinfected, and that the drains of the said premises should also be cleansed and disinfected, and that certain articles should be destroyed, notice is hereby given that unless within twenty-four hours from the receipt of this notice you inform the Board of Health, in writing, that within a further period of hours you will carry out the cleansing and disinfecting operations, and the destruction of certain articles hereinafter mentioned, the Board of Health will enter on the said premises and carry out the said cleansing and disinfecting operations and the destruction of the said articles at your expense, in pursuance of the powers vested in them by the provisions of the Public Health Act.

Particulars of cleansing and disinfecting operations required

List of articles to be destroyed

Note.—All such cleansing and disinfecting operations, and the destruction of such articles, must be done to the satisfaction of a legally-qualified medical practitioner.

Date of Service

Hour of Service

Inspector.

Under this notice you may elect to take any of the following courses:—

"A" To cleanse and disinfect the premises yourself within the period mentioned in the notice.

"B" To request the Board of Health to undertake the cleansing and disinfecting of the premises.

Penalties for Non-compliance.

If, having elected to carry out the required operations, you fail to do so within the time mentioned, a breach of the Act will have been committed.

Note.—In addition to the penalties incurred under the Public Health Act, you will be liable to have your premises placed in quarantine and isolated.

C. A. SIMMS,
Secretary.

No. Form No. 265.

Department of Public Health, N.S.W.

Notice under the Public Health Act.

To occupier of situated at No. street.

You are hereby notified that the undermentioned works must be executed before your premises can be certified as sanitary,

To avoid institution of proceedings against you under the provisions of the Public Health Act, the improvements must be taken in hand at once, and most be completed within from date of service of this notice.

Date of Service Inspector.

Hour of Service

[Five Plates, One Diagram, Four Plans.]

Sydney: William Applegate Gullick, Government Printer.—1901.

[7s. 6d.]

PLATE 1.

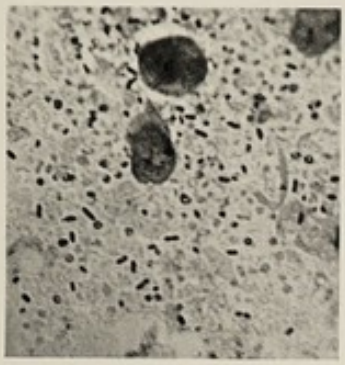


FIGURE 1.
FROM A BUBO. X 1000.

FIGURE 2.
FROM AN AGAR CULTURE. X 1000.

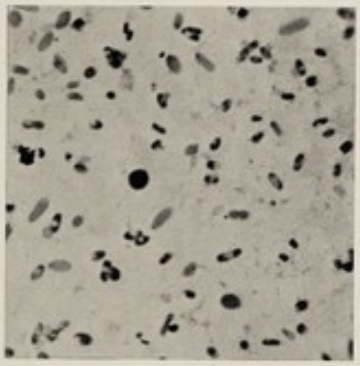


FIGURE 3.
FROM A DRY AGAR CULTURE. INVOLUTION FORMS.
X$\frac{1}{12}$ 1000.

FIGURE 4.
FROM A BOUILLON CULTURE. X$\frac{1}{12}$ 1000.

FIGURE 5.
SMEAR PREPARATION FROM A FLEA. X 1000.

Frank Tidwell.

BACILLUS PESTIS BUBONICÆ.

FIGURE 6.
FROM A CARBUNCLE. CASE OF J.D. X$\frac{1}{12}$ 1000.

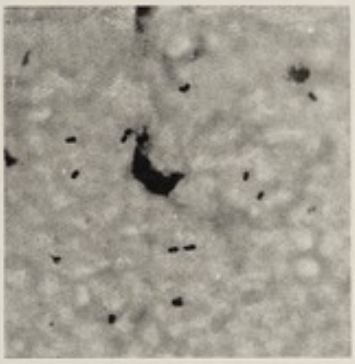


FIGURE 7.
FROM BLOOD OF HEART. INOCULATED GUINEA-PIG. X$\frac{1}{12}$ 1000.

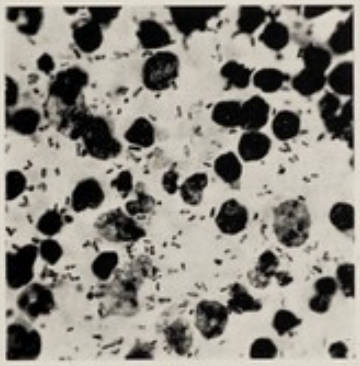


FIGURE 8.
FROM THE SPLEEN. CASE OF E. M'C. X$\frac{1}{12}$ 1000.

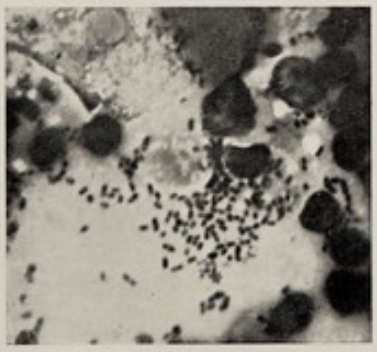


FIGURE 9.
FROM A BUBO. NATURALLY INFECTED CAT. X 1000.

FIGURE 10.
FROM THE LIVER. NATURALLY INFECTED RAT. X 1000

Frank Tidswell.

BACILLUS PESTIS BUBONICÆ.

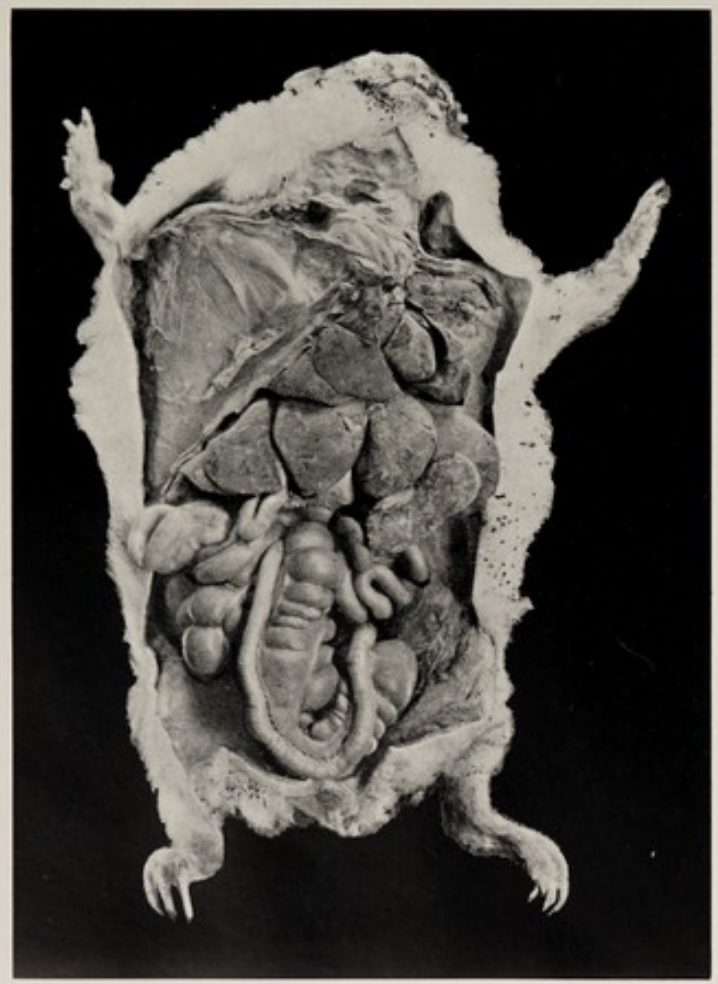


FIGURE 11.

PATHOLOGICAL APPEARANCES IN A GUINEA-PIG. PNEUMONIA, ENLARGEMENT OF THE LIVER, ENLARGEMENT AND MILIARY MOTTLING OF THE SPLEEN, BUBO IN THE LEFT GROIN.

FIGURE 12.

PATHOLOGICAL APPEARANCES IN A GUINEA-PIG. PNEUMONIA WITH NECROTIC POINTS IN THE LUNGS, ENLARGEMENT OF THE LIVER, ENLARGEMENT AND MILIARY MOTTLING OF THE SPLEEN, BUBO IN THE RIGHT GROIN.

PATHOLOGICAL APPEARANCES IN INOCULATED GUINEA-PIGS.

Frank Tidswell.

FIGURE 13.

DISSECTION OF AN INOCULATED GUINEA-PIG, SHOWING HÆMORRHAGES IN THE KIDNEYS, ENLARGEMENT AND CONGESTION OF THE SUPRARENAL BODIES, BUBO IN THE RIGHT GROIN, WITH HÆMORRHAGIC EXUDATION EXTENDING INTO THE PELVIS.

FIGURE 14.

DISSECTION OF THE GASTRO-INTESTINAL TRACT OF A RAT DEAD AFTER BEING FED UPON INFECTED VISCERA, SHOWING ENLARGED AND CONGESTED LYMPHATIC GLAND CONNECTED WITH THE STOMACH, CONGESTION OF THE MESENTERIC BLOOD-VESSELS, HÆMORRHAGIC EXUDATION AT FIRST PART OF LARGE INTESTINE, AND A MASS OF SWOLLEN MESENTERIC LYMPH GLANDS.

Frank Tidswell.

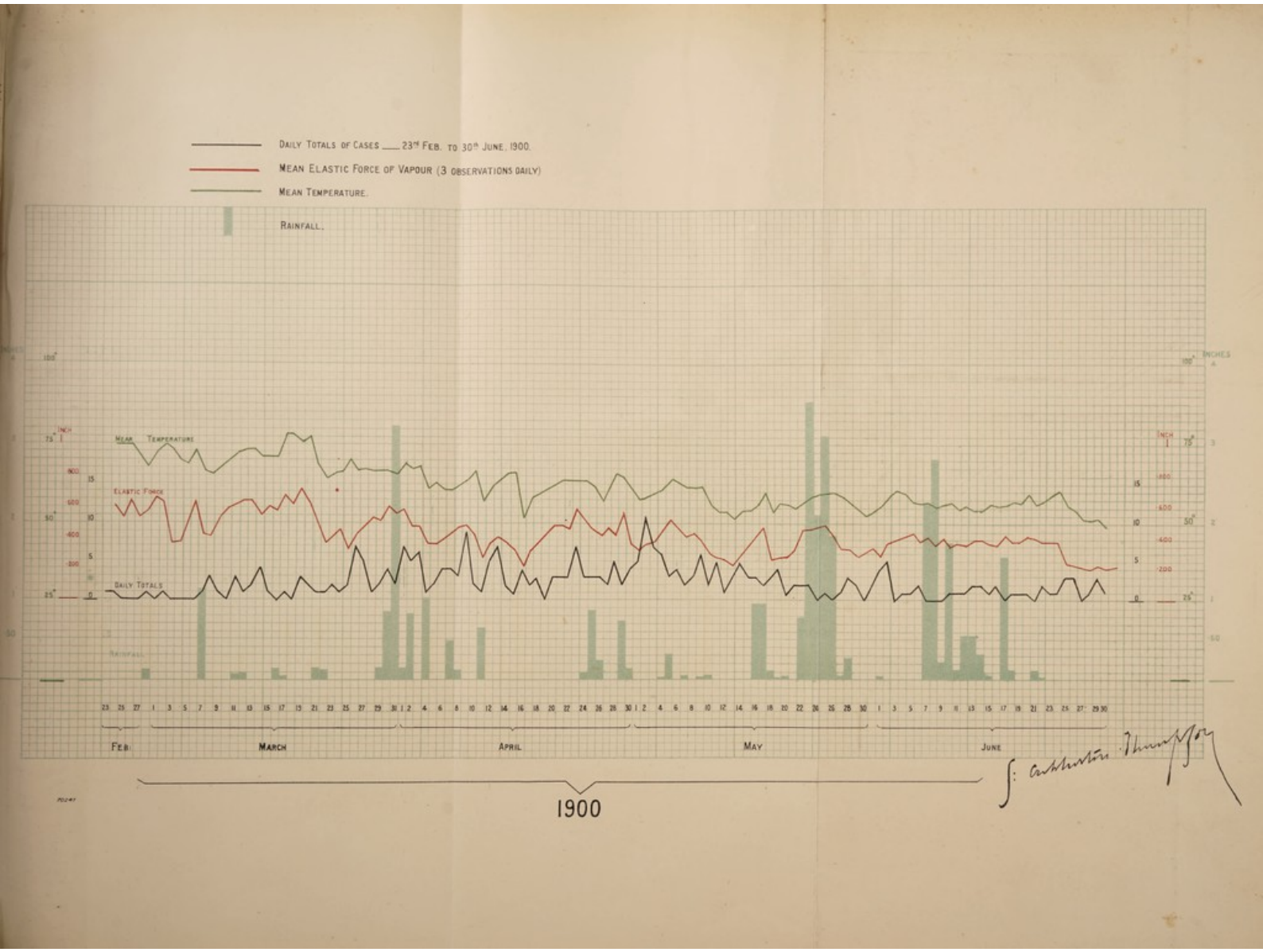
DISSECTIONS OF GUINEA-PIG AND RAT.

FIGURE 15.
PATHOLOGICAL APPEARANCES IN A NATURALLY INFECTED RAT. PNEUMONIA, ENLARGEMENT OF LIVER, SPLEEN AND AXILLARY GLANDS.

FIGURE 16.
PATHOLOGICAL APPEARANCES IN A NATURALLY INFECTED RAT. ENLARGEMENT OF LIVER AND SPLEEN.

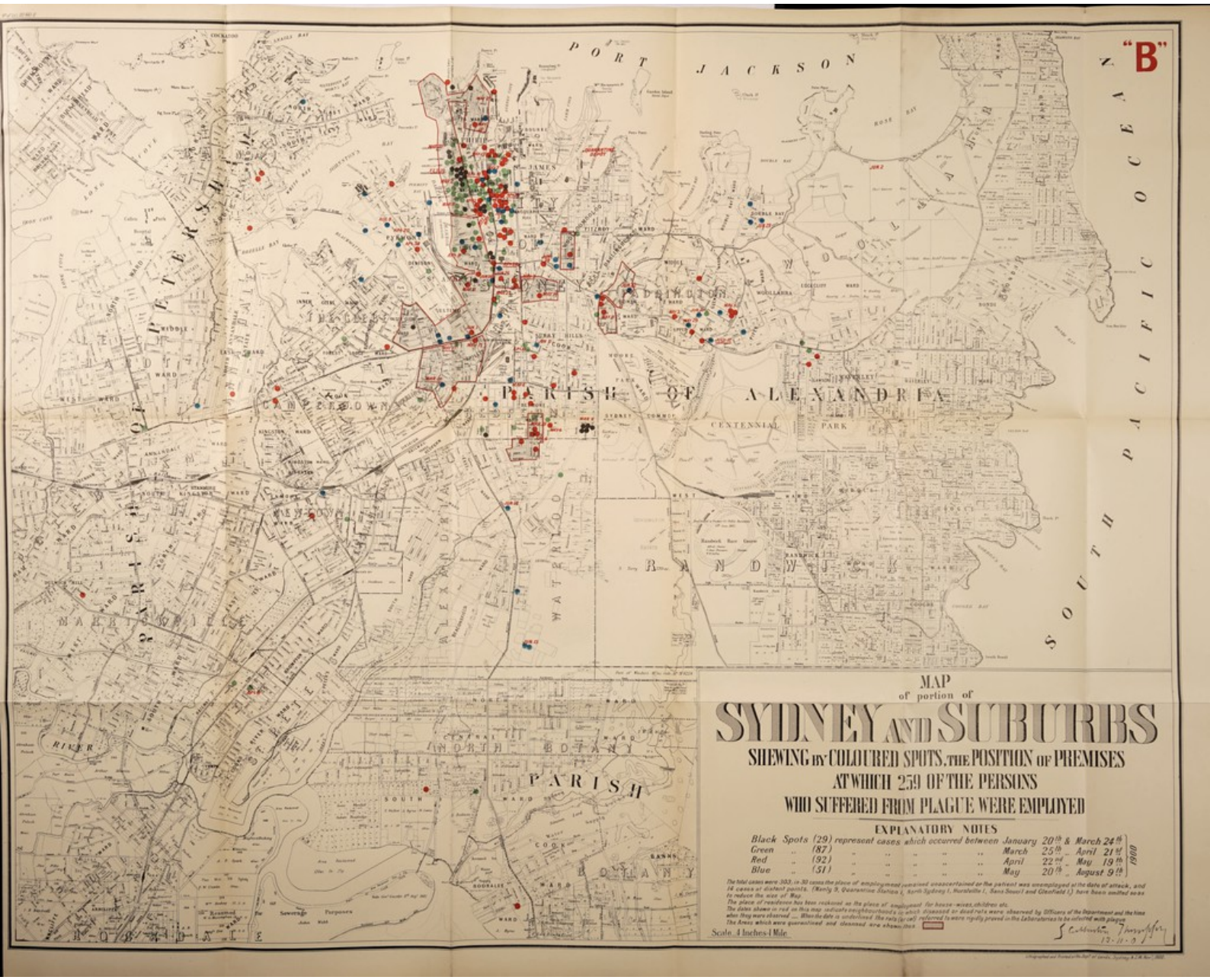
PATHOLOGICAL APPEARANCES IN NATURALLY INFECTED RATS.

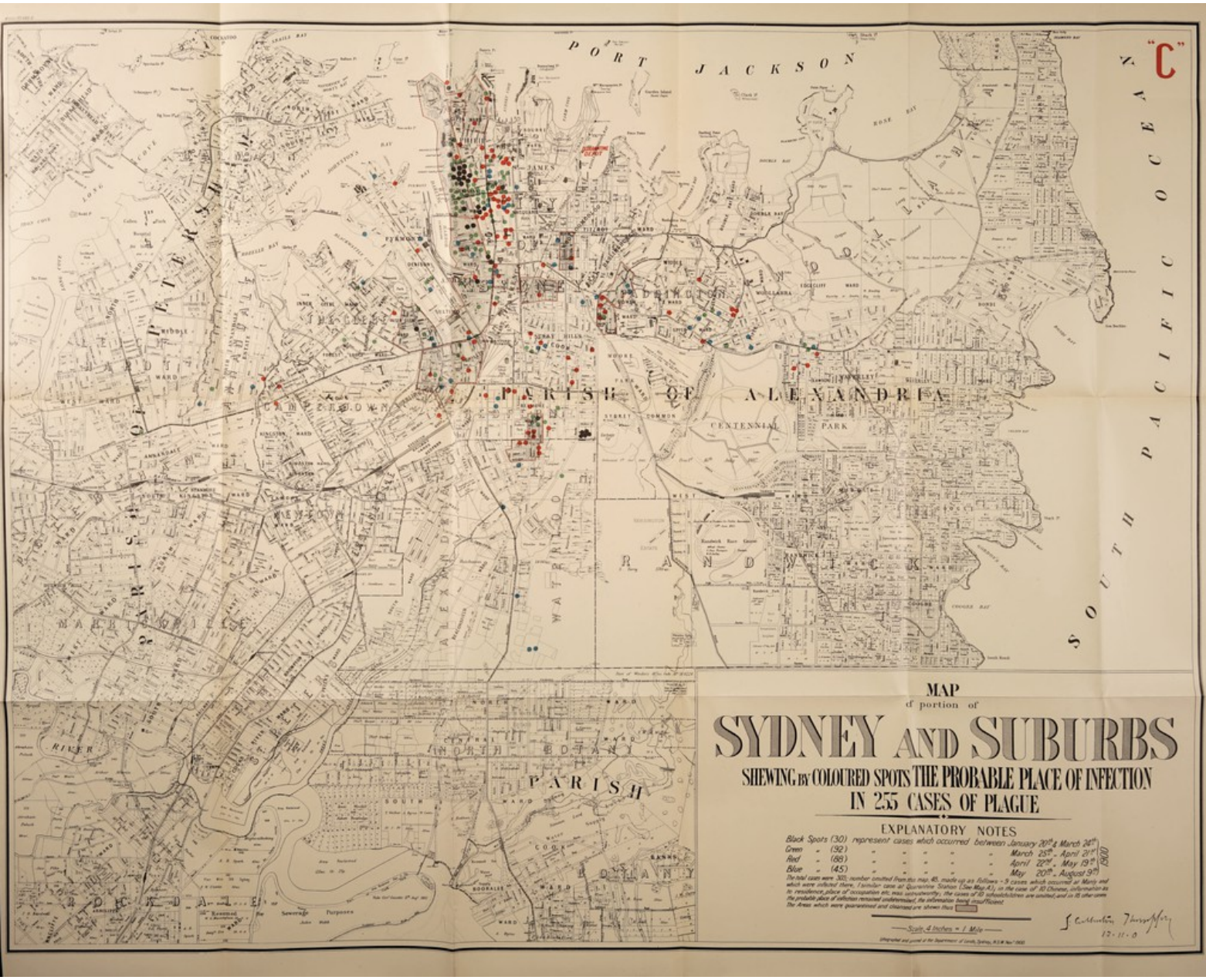
Frank Tidswell.


Daily Totals of Cases ___ 23rd Feb. to 30th June, 1900.
Mean Elastic Force of Vapour (3 observations daily)
Mean Temperature.
Rainfall.
Mean Temperature
Elastic Force
Daily Totals
Rainfall
Feb.
March
April
May
June
1900


MAP
of portion of
SYDNEY AND SUBURBS
SHEWING BY COLOURED SPOTS THE POSITIONS OF THE HOUSES OCCUPIED BY 294 PERSONS WHO SUFFERED FROM PLAGUE
EXPLANATORY NOTES
Black Spots (32) represent cases which occurred between January 20th & March 28th
Green " (96) " " " " March 25th " April 21st
Red " (104) " " " " April 22nd " May 19th 1900
Blue " (62) " " " " May 20th " August 5th
The total cases were 303, 3 had no fixed residence and 6 cases at distant points (Waverley I, Cleveland I, Goldfield I, Sans Souci I, Hurstville I, and Mansfield I), have been omitted so as to reduce the size of Map.
On this Map are shown the position of the Maritime Quarantine Station where the Plague Hospital and Contact Camp were established, and that of the Quarantine Depôt where the Observation and Disinfecting Staffs were accommodated.
The Areas which were quarantined and cleansed are shown thus
"A"
QUARANTINE RESERVE
MIDDLE HARBOR
NORTH HARBOR
WILLOUGHBY
LANE COVE
LANE COVE RIVER
PARRAMATTA RIVER
DRUMMOYNE
PORT JACKSON
OCEAN


CONCORD
PARISH OF ALEXANDRIA
PACIFIC
SOUTH
CANTERBURY
PARISH OF ST GEORGE
BOTANY BAY
BOTANY
PARISH OF BOTANY
CHURCH AND SCHOOL ESTATE
COOKS RIVER
CENTENNIAL PARK


"B"
PORT JACKSON
SOUTH PACIFIC OCEAN
PARISH OF ALEXANDRIA
CENTENNIAL PARK
RANDWICK
WATERLOO
ALEXANDRIA
PARISH
NORTH BOTANY
SOUTH BOTANY
BOTANY BAY
ROSEBERY
MAP
of portion of
SYDNEY AND SUBURBS
SHEWING BY COLOURED SPOTS, THE POSITION OF PREMISES
AT WHICH 259 OF THE PERSONS
WHO SUFFERED FROM PLAGUE WERE EMPLOYED
EXPLANATORY NOTES
Black Spots (29) represent cases which occurred between January 20th & March 24th
Green .. (87) .. .. March 25th & April 21st
Red .. (92) .. .. April 22nd & May 19th
Blue .. (51) .. .. May 20th & August 9th
1900
The total cases were 303, in 30 cases the place of employment remained unascertained or the patient was unemployed at the date of attack, and 14 cases at distant points. (Manly 9, Quarantine Station 1, North Sydney 1, Hurstville 1, Rand Sweet and Glenfield 1.) have been omitted so as to reduce the size of Map.
The place of residence has been reckoned as the place of employment for house-wives, children etc.
The dates shown in red on this map indicate neighbourhoods in which diseased or dead rats were observed by Officers of the Department and the time when they were observed. When the date is underlined the rats (or rat) referred to were rightly proved in the Laboratories to be infected with plague.
The Areas which were guaranteed and cleansed are shewn thus
Scale 4 Inches-1 Mile.



MAP
of portion of

SYDNEY AND SUBURBS

SHEWING BY COLOURED SPOTS THE PROBABLE PLACE OF INFECTION IN 255 CASES OF PLAGUE

EXPLANATORY NOTES

Black Spots (30) represent cases which occurred between January 20th & March 24th
Green " (92) " " " " March 25th - April 21st
Red " (88) " " " " April 22nd - May 19th
Blue " (45) " " " " May 20th - August 9th
1900

The total cases were 305; number omitted from this map, 45, made up as follows - 9 cases which occurred at Manly and which were collected there, 1 solitary case at Quarantine Station (See Map A), in the case of 10 Chinese, information as to residence, place of occupation etc. was unobtainable, the cases of 10 schoolchildren are omitted, and in 15 other cases the probable place of infection remained undetermined, the information being insufficient.
The Areas which were quarantined and cleansed are shown thus

Lithographed and printed at the Department of Lands, Sydney, N.S.W. Nov 1900

12-11-0

1903.

LEGISLATIVE ASSEMBLY.

NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

SECOND OUTBREAK OF PLAGUE AT SYDNEY, 1902.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President,

Chief Medical Officer of the Government.

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[Twenty-eight Tables. Four Diagrams. Two Plates.]

REPORT

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ON A

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BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President
Chief Medical Officer of the Government.

PREFACE.

July 31*st*, 1903.

ON reviewing the events of the epidemic of 1902, it appears that they justify and enforce the advice on management of epidemic plague which was given in the official "Report on the Outbreak of Plague at Sydney, 1900"; this, therefore, need not be repeated on the present occasion, which will be used to investigate further the causes of epidemic plague.

2. In other parts of the world, the maintenance and spread of plague are ascribed to human intercourse—directly with the sick, or indirectly through articles which have been infected by them—and to place-infection.

3. It has been shown that the epidemic of 1900 was not caused by direct communication with the sick, nor by diffusion of infected articles, nor by place-infection. These observations on the mode of spread we have now had opportunity of checking. They have been confirmed and amplified.

4. The share which may be played by the rat in causation of epidemic plague has been left a doubtful matter by the evidence which has been gathered elsewhere. All that has been ascertained is that man and the rat are susceptible of an identical infection. That plague is primarily a disease of the rat; that it is commonly communicated to man from the rat; or that man and the rat in usual circumstances of propinquity are reciprocally infective, have but been shown to be probable conjectures; for it has also been said* that sometimes an epidemic has taken precedence of the epizoötic, and even that in different places each has run its course unattended by the other. In short, no more than an occasional, though frequent, concurrence between the two has been remarked, and the question whether epizoötic plague be a cause or an incident of epidemic plague has been left unanswered by the observations thus far recorded in other countries.

F.

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* Indian Plague Commission, Report 1901, Section 292.

5. Here, in Sydney, we formed the opinion in 1900 that plague-rats constituted the sole source from which the infection was communicated to man. A good deal of evidence in support was furnished, but it was, and under then circumstances almost necessarily was, incomplete. It has now been largely supplemented. How far it reaches towards demonstration of causative association between plague-rats and individual cases of plague is left to the reader's judgment. It is shown below that the task of fully examining into, and of exhibiting, the relationship referred to is one of great difficulty in any city.

6. But supposing the invariable precedence of rat plague and a constant association of plague-rats with individual plague cases to be established: Another and important difficulty presents itself, which is that in all probability the rat unaided cannot cause epidemic bubonic plague. An intermediary is necessary to convey this septicæmia of the rat to man. Whether that intermediary may consist in inanimate objects on which plague-rats have deposited the infection in a way to facilitate its effective contact with man, is a question which is discussed at length below. Some ground for answering it in the negative is there shown.

7. It has been already noted (Report, 1900, p. 38) that Simond had suggested in 1898* that the requisite intermediary might be furnished by the flea and the bed-bug. Personally, I had accepted this suggestion before the disease had appeared here, on the ground that it served to explain a greater number of reported, and apparently discordant, observations than any other which had been made; and when the first case of the epidemic of 1900 occurred which, as it happened, indirectly exemplified it, I took it for guide, although the proofs adduced had remained uncorroborated, and although direct experiments by Nuttall† (which were made, however, with Cimex only) had yielded negative results. By the end of that epidemic it had been generally accepted in this Department on the ground that it, and it alone, appeared capable of co-ordinating the observed facts; and, notwithstanding an adverse remark on "rat-fleas" made by Netter‡, and vivacious contributions on the same subject by Professor Galli-Valerio§, which intervened, we regarded it with similar favour at the end of the second epidemic. Attention has now been given to determining the species of the fleas which infest rats in this part of the world, to variations in their frequency on rats at different times, and to examining into their ability to bite man.

8. The importance of the foregoing remarks, which, to those who are content with the simple theory which is expressed in the one word "rat," will appear recondite and superfluous, lies in this: That while our experience regarding non-diffusion of the infection by direct or indirect communication with the sick and non-maintenance by place-infection, is not the same as has elsewhere been recorded, it has yet been acted upon by us with an apparent diminution of the number of persons attacked, together with large saving of direct expenditure, and avoidance of many of the indirect occasions of loss to individuals which, in spite of our advice, were caused to operate so largely during the first epidemic.

9. And now, unnecessary though it be to repeat all the advice on management of epidemic plague which was given in 1900, because it has but been corroborated by the further experience of 1902, it is yet well to recall the most important of the lessons which we then inculcated. This, repeated to-day with the emphasis which such corroboration warrants, runs as follows:—The promise of safety for the future lies neither with attempts to prevent the importation of plague-rats (which must fail from time to time), nor with attempts to exterminate the rats infesting the locality to be defended (which we have learned is practically impossible), though both of these measures have their valuable uses, but in habitually excluding rats from inhabited premises. This, manifestly, is a defence which can be set up successfully by Local Authorities; it requires persistent effort, but involves hardly any expenditure of municipal funds.

* Annales de l'Institut Pasteur, 1898. † Johns Hopkins Hospital Reports, VIII, pp. 17-21. ‡ La Peste et son Microb., Paris, 1900. § Cent. f. Bakter, XXVII, p. 1, and XXVIII, p. 842.

Part I.—The Epidemic.

10. The last case of the epidemic of 1900 was notified on 9th August of that year. An interval of rather more than fifteen months ensued, during which careful watch was kept for commencement of the recurrence which was feared; but among the many cases which were reported for diagnosis during its continuance, there were but two which afforded good ground for *primâ facie* suspicion, and after investigation it was shown that both were due to streptococcic infection. The rats which infested the areas on which cases had arisen were also watched until it appeared probable that the epizoötic of plague which had prevailed among them had died out.

11. That long interval was determined by attack of a man on 4th November, 1901; his case was notified on 12th November. A free term of thirty-four days ensued, and then, on 8th December, a second man was attacked. After a further free term of about thirty-five days, a woman fell ill on 10th or 11th January, 1902. During these two intermissions several cases of illness were reported for diagnosis, but no case of plague, nor any in which there was real ground for doubt, was among them. The epidemic declared itself with the third case, and, as the last patient was attacked on 8th June, it may be referred to conveniently as the epidemic of 1902. It consisted of 139 cases, of which 39 ended fatally, and is the subject of the present account.

12. On 6th August, however, one further case occurred at Newcastle. It was "indigenous" to that city, but, thanks to the measures immediately taken it remained solitary, and the danger to which that important seaport had been exposed was averted. It is separately described below.

Management of the Epidemic.

13. Management of the epidemic rested with the Board of Health. Mr. Edmund Fosbery, C.M.G., who had been appointed by the Board to act as President during my absence on leave, and the Principal Assistant Medical Officer of the Government and Micro-Biologist to the Board (Dr. Frank Tidswell, M.B., D.P.H.), who at the same time had taken up the duties of the chief executive post, occupied those positions at its beginning. I resumed control on 7th March.

14. The method of management differed essentially from that actually followed in 1900 in three important respects. First, in 1900 we had pointed out, in the course of our report on the case of A.P. (Case 1), dated 7th February, that the Coast Hospital was the only suitable place to which plague cases could be sent for isolation and treatment, and had repeated this recommendation several times during the earlier part of the epidemic. Secondly, we had announced, on 2nd March (Case 5), that it was unnecessary to segregate contacts, and that for the future we should, as a rule, remove only the sick from dwellings. Thirdly, on 23rd March (Case 32), we had so far expressed our opinion as regards probable diffusion of infection by merchandise as to give instructions that the latter might be removed in the ordinary course of trade from the Adelaide Bond, which stood on that infected area which was the first to be quarantined for cleansing. But the head of the Government of the day declined these several advices; and, as a matter of fact, patients were strictly isolated in the buildings, utterly inadequate to this purpose, and accessible with difficulty, which alone the Maritime Quarantine Station at North Head afforded, all contacts were segregated at the same place, and cleansing areas were as strictly closed, or "quarantined," during cleansing as physical circumstances permitted.

15. In 1902 our advice was implicitly accepted; and consequently, as regards the three points mentioned, we did as we had wished to do in 1900. First, the sick were sent to wards within the Infectious Diseases Division of the Coast Hospital, where they were dealt with almost exactly as though they had been suffering from measles or from some other of the commoner infectious fevers; the only difference was that visitors, though discouraged, were more freely admitted than would have been the case had the disease been measles in fact. No other special precaution was taken than that of rendering the wards rat-proof; and the general economy of the hospital was disturbed only by the number of patients suffering from this one disease for whom

whom accommodation had to be found. Secondly, the sick alone were removed from their dwellings. The other members of the households to which they belonged were not interfered with. They were told that their premises were probably infective, and were advised to withdraw from them until they had been disinfected, when the circumstances required this, but they were never compelled to move; neither were they supervised, except for a short time quite at beginning of the epidemic. Pending completion of disinfection, entrance to the house where the patient had lain was forbidden to all but the residents, but the latter were allowed to go in and out. Disinfection was always very promptly done, and was usually finished within thirty-six hours of the patient's removal; though in the case of extensive premises the time was much lengthened, and access to theatres, hotels, and the like was denied to the public until the structural repairs necessary to exclude rats had been completed. Thirdly, areas which were deemed to be infective were rapidly and thoroughly cleansed, but they were not closed during that operation; movement of population and trade were in no way interfered with.

16. These changes constituted remarkable ameliorations. Were they beneficial under all aspects? The following comparison permits the inference that they were so, and in a striking degree.

TABLE I.—Comparing the Epidemics of 1900 and of 1902, as regards number of attacks, fatality, and cost.

Epidemic.	Number of		Fatality.		Cost.
	Cases.	Deaths.	Gross.	Chinese Excluded.	
					£
1900	303	103	34·0	32·4	176,000
1902	139	39	28·0	25·75	24,000

PROGRESS OF THE EPIDEMIC.

17. At the Census of 1901 the population of the Metropolitan Registration District was 487,932, and this included a total of 3,842 Chinese, of whom only 222 were females. Among the whites 132 cases of plague occurred, of which 34 ended fatally; among the male Chinese 7 cases, of which 5 ended fatally. The manner in which these cases made appearance is shown in the Table below.

TABLE II.—Showing the number of attacks which occurred in each week of the epidemic, and the number of weekly attacks which ended fatally; together with the number of cases notified during each week.

	Attacks.	Deaths.	Notifications.		Attacks.	Deaths.	Notifications.
1901.				1902—(*contd.*)			
9 November	1	0	0	8th week— 1 March	14	4	16
16 „	0	0	1	9th „ — 8 „	5	0	7
30 „	0	0	0	10th „ —15 „	12	5	10
23 „	0	0	0	11th „ —22 „	18	3	14
7 December	0	0	0	12th „ —29 „	8	1	12
14 „	1	1	1	13th „ — 5 April	5	0	5
21 „	0	0	0	14th „ —12 „	1	0	4
28 „	0	0	0	15th „ —19 „	6	1	4
1902.				16th „ —26 „	8	2	7
4 January	0	0	0	17th „ — 3 May	5	3	7
1st week—11 „	1	0	0	18th „ —10 „	6	1	8
2nd „ —18 „	2	0	1	19th „ —17 „	7	3	5
3rd „ —25 „	3	1	5	20th „ —24 „	2	1	3
4th „ — 1 February	0	0	0	21st „ —31 „	2	0	1
5th „ — 8 „	5	2	5	22nd „ — 7 June	5	2	3
6th „ —15 „	9	4	7	23rd „ —14 „	1	0	5
7th „ —22 „	12	5	8		139	39	139

18. The first case occurred during the week ending 9th November, 1901. For thirty-four days it stood alone; a second then happened during the week ending 14th December. After another interval of thirty-five days a third person was attacked during the week ending 11th January, 1902, and with this the epidemic began. The first two cases being excepted, during the first six weeks (ending 15th February) 20 persons were attacked; during the second six weeks, 69 persons; during the third, 31; while during the latter five weeks, only 17 were attacked. These figures, which result from division of the series shown in Table II, column of attacks, in accordance with the marked increase in the weekly number of attacks during the seventh to the twelfth weeks, distinguish periods of increase, state, and decline of the epidemic. The onset of the epidemic was marked by extreme deliberateness at first, and by an almost regular acceleration in its later stages; while its end during the week ending 14th June was abrupt and decisive. No doubtful cases were met with thereafter.

19. *By whom notified.*—Of the above cases, 22 were notified from public hospitals, 92 by fifty-five medical practitioners, and the remaining 25 by staff medical officers, by coroners, by the police, by friends, and by themselves, in about equal numbers.

20. *Cases reported for Diagnosis.*—Between 12th November, 1901, when the first case was notified, and 31st July, 1903, 112 cases of illness, which turned out not to be plague, were reported for diagnosis. Only one of them afforded good clinical ground for doubt, but the morphological, cultural, and inoculation tests which were applied to liquid abstracted from a swollen inguinal gland failed to reveal any micro-organism or any infective disease. One other gave clinical ground for doubt in a lesser degree, and was shown to be a case of streptococcic infection connected with a chronic ulcer of the leg.

21. *Ambulant Cases.*—These did not exceed seven or eight in number altogether. But they could not be exactly discriminated, because they were exhibited both in persons who had personally applied for treatment immediately after attack and who subsequently passed through a well-marked illness, and in persons who had passed through a mild acute stage without medical aid, and who applied for help during convalescence, either for persistent weakness or for indurated and painful glands. This, with addition of two or three cases which ultimately came to light in consequence of late suppuration of glands, is what was observed during the epidemic of 1900; and, as on that occasion, the circumstances under which these cases came to notice render it likely enough that a few others may have occurred in which either advice never appeared to be necessary, or else was sought at so late a date that the true cause of illness was not discovered. Neither in 1900 nor during the epidemic under notice did we note anything which would give colour to a suggestion that cases of pestis minor occurred, or cases of benign glandular enlargement probably taking their origin from a very mild and successfully resisted infection with plague. We have no practical knowledge of either of these described conditions.

22. *Clinical Forms.*—Of the 139 cases, 133 were of the bubonic form, 6 were of the septicæmic form. These proportions were practically the same as were observed in 1900, and, as on that occasion, no case of primary plague-pneumonia was met with. The general course of the disease was the same as has been already described (see Report, 1900, pp. 3–7), but the following three clinical notes are worthy of record.

23. *Mode of Onset.*—This was often sudden. Thus the exact hour of attack was named by 22 patients; that is to say, they alleged that having been in good health they had fallen ill "at 5 o'clock in the morning," or "at half-past three in the afternoon," &c. In 71 cases, though the hour of attack could not be exactly fixed, yet it was ascertained to have been during the first 6 hours after midnight in 9 of them, during the second 6 hours in 18, during the third 6 hours in 22, and during the fourth in 22. So in 19 other cases in which nothing exact was noted on this point, in 8 the attack was said to have been "sudden," and in 11 others to have occurred "while at work." In 14 cases the onset was definitely ascertained to have been gradual.

24. *Onset Symptoms.*—These almost always consisted in headache and general malaise, nausea, followed sooner or later by vomiting, and shivering; a feeling of feverishness set in early, or else after a few hours. To these symptoms diarrhœa and colic were rather often added. At the onset, also, the patient's attention was frequently attracted to the gland in which the bubo afterwards developed. Thus, in 13 cases sharp and continued pain in the gland, accompanied or not by perceived enlargement, preceded all other symptoms, and was the first indication that the infection had been received; while in 24 others, similar pain with or without swelling was noted to have been among the onset symptoms, and to have been noticed as soon as headache, shivering, &c. had informed the patient that he was ill.

25. *Situation of Buboes.*—In 123 instances (32 deaths) the bubo was solitary; in 106 of these it was situated in the inguinal region, having been in one of the vertical set of glands in 60, and in one of the oblique set in 46 of them. In 10 instances (3 deaths) the glandular enlargements were multiple: in 2 instances (1 death) in two regions on the same side; in 7 instances (2 deaths) in the corresponding regions on two sides; and in 1 instance in two corresponding regions on two sides of the body. In 6 instances (4 deaths) there was no bubo.

26. *Interval between Attack and Notification.*—This can be stated in 139 cases, and was as follows:—

TABLE III.—Showing the interval which elapsed between attack and notification in 139 cases of plague.

Notified on the day of attack	10
„ one day after „	31
„ two days after „	27
„ three „ „	31
„ four „ „	13
„ five „ „	9
„ six „ „	5
„ seven „ „	2
„ eight „ „	4
„ nine „ „	2
„ ten „ „	3
„ eleven „ „	1
„ twenty-three days after attack	1
Total	139

27. *Interval between Notification and Removal.*—This has administrative as well as ætiological interest. It was as follows:—

TABLE IV.—Showing the time which elapsed between the notification of cases, and their removal to hospital.

Removed on the day of notification	90
„ one day after „	28
„ two days after „	6
Not removed, having fallen ill in country	1
Died before or at notification	14
Total	139

So that of 124 patients who could be dealt with in the ordinary course, 118 were removed to hospital either on the day of notification, or, having been notified too late for removal by daylight, the next morning; while removal was deferred for two days in the remaining six cases, because the state of the patient at the date of notification was such as precluded his immediate removal with safety.

28. *Protective Inoculation.*—No public, and very little detail, inoculation was done during this epidemic. Two alone of the persons attacked asserted that they had been inoculated. Case 2: The patient was said to have been inoculated (Haffkine) at Rockhampton, Queensland, nearly 2 years before attack; this statement was verified*; he died. Case 95: The patient alleged that he had been inoculated (Haffkine) early in 1900, at Sydney, but his name could not be found in the list of names of persons then publicly inoculated; he recovered.

29. *Sex-incidence.*—Somewhat more than twice as many males were attacked as females. In 1900, this proportion was very much larger.

30.

* By Dr. B. Furnett Ham, Commissioner for Public Health, Queensland.

30. *Age-incidence.*—The observed incidence was on ages 4 years to 75 years. About 60 per cent. of the total cases were aged between 15 and 35, and about 80 per cent. were aged between 15 and 45. A larger proportion of persons both above and below the age-groups mentioned was attacked in 1900.

TABLE V.—Showing the number of attacks and of deaths distributed under Sexes and Age Groups.

Age Group.	5		10		15		20		25		35		45		55		65		75		Total.	
Sex.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Attacks...	0	1	4	2	13	6	12	3	8	8	25	9	20	9	7	1	2	2	5	2	96	43
Deaths ...	0	1	1	0	3	1	4	0	4	0	6	3	6	2	1	0	1	2	2	2	28	11

31. *Fatality.*—The total number of cases having been 139, and the deaths 39, the gross fatality was almost exactly 28 per cent.; and this was rather more than 6 per cent. below the gross fatality observed in 1900. Some part of this reduction may be apparent, and due merely to the smaller number of cases and of deaths dealt with; but as the gross fatality of 34 per cent. in 1900 was reduced to 32·4 per cent. for whites only, by deduction of 10 cases and 8 deaths among the Chinese, so the gross fatality of 28 in 1902 is reduced to 25·75 for whites only, on subtraction of 7 Chinese, and of the 5 deaths which occurred among them. These deductions are justifiable on the ground that experience has shown that the Chinese (and other coloured races) always resist this disease very much less successfully than do the whites.

32. *Fatality at successive periods.*—The fatality of the disease in each of the four successive periods already mentioned was as follows:—

TABLE VI, showing the fatality of the disease during four successive periods of the epidemic.

Period.	All cases.			Chinese deducted.		
	Cases.	Deaths.	Fatality.	Cases.	Deaths.	Fatality.
Early cases	2	1	...	2	1	...
1st– 6th week	20	7	35·0	20	7	35·
7th–12th „	69	18	26·0	67	17	25·3
13th–18th „	31	7	22·5	28	4	14·3
19th–23rd „	17	6	35·3	15	5	33·3
Totals	139	39	28·0	132	34	25·75

33. If the Chinese be deducted the fatality for these four successive terms becomes 35, 25, 14, and 33. The smallness of the figures dealt with may account for some irregularity in the series; and if the 4 periods be reduced to 2, namely, of 12 and of 11 weeks, then (the Chinese being still excluded) the fatality during them was 27·6 and 21· respectively. This seems to point to a diminishing virulence of the infection. But as the second term yielded but 43 cases much stress cannot be laid on this inference; and if the fourth column of the preceding Table be referred to, it appears that the fatality during the last of the four periods was rather above that of the first period. In this comparison, too, however, the figures are too small to carry weight. And yet just as it was necessary to point out that cases which seemed to betoken unimpaired virulence of the infection were met with at the very end of the epidemic of 1900 (Cases 289, 295, and 303), so now it has to be noted that of 6 persons attacked during the last fortnight of the second epidemic, 2 died, while one of these illnesses (Case 134) had a duration of

seventy-five

seventy-five hours only, although the patient was a man of 24, and in excellent health at the time he received the infection. Extinction of the epidemic was not due, then, to enfeeblement of the virus, or if in some degree due to this, was not due to it alone.

34. *Fluctuation in the weekly number of attacks.*—The larger number of persons attacked during the second period of six weeks, was almost entirely associated with the city of Sydney, and very largely with that central part of the city along which George-street runs, and which is bounded on the west by Darling Harbour. That is the centre of the business portion of Sydney, and consequently is more thickly populated during day-light hours than any other. The persons referred to did not live in this locality, or did so in very small proportion; they merely resorted there during the day. Those of them who resided at a distance did so for the most part in neighbourhoods which there was no tangible reason for suspecting of infection with plague; on the other hand, they were easily connected with individual premises in that part of the city which were either shown to have yielded dead rats in number, or in the immediate neighbourhood of which rats actually infected with plague had been identified. In short, the weekly increase referred to appeared to be associated with wider prevalence of the epizoötic on a thickly-populated area.

Communication between successive Cases.

35. This was the subject of careful inquiry in every case. No communication was detected or suspected between any case and a preceding case, except on premises which yielded multiple cases; except also the 4 cases which occurred at 2 adjoining cottages on the Paddington area; except, also, 3 cases which occurred in two adjoining cottages on the Pyrmont area; except, lastly, case 102, Chippendale area, with which patient at the time of her attack (18th April) was a woman who had been seized 20th February, admitted to hospital 26th February, and discharged therefrom 18th March. All of the instances referred to are fully described in their place, and the nature of their relation to each other is there discussed at length.

Evidence as to Place Infection.

36. The Plague Commission in India summed up the evidence it had gathered as to place-infection and the maintenance of the disease by that condition in the following sentences:—" . . . the universal experience of plague in India proves . . . that houses into which the infection of plague has been imported, whether by men or by rats, are infective . . . "; and "the general experience on this question is summed up in the expression current in India that plague is essentially a disease of locality."* What evidence on this important point has been furnished by experience at Sydney?

37. In 1900 the number of dwellings which *harboured* cases of plague (that is to say, whether they were or were not adjudged places of infection for those cases) was 286. Only 10 of them yielded multiple cases; in 3 of them the secondary cases occurred before removal, and at or near the same time as the primary case; in 4 the secondary cases occurred after separation from the primary case, and from the dwelling; and in 3 only did the secondary cases occur among the household after its removal from the premises, after the latter had been disinfected, and after the household had returned to them. In this small minority of 3 dwellings out of 286, then, there was *primâ facie* evidence of place-infection; and the whole of that inquiry went to show that the epidemic was associated with place in some sense or another. But this localisation of the infection was considered to have consisted merely in the casual presence of plague-rats; and it was pointed out that infectiveness of some of the premises standing on an area otherwise known to be infective was just what might be expected to continue notwithstanding disinfection if it depended on the incoming of infected rats, and not on infection resident in the place itself.†

38. Further, 221 premises (whether dwellings or places of employment) were adjudged in 1900 to have been places at which 255 cases had received their infection (see Diagram C, 1900).

39.

* Report 1901, par. 221. † Report, Sydney, 1900, p. 38.

39. Now, as regards 1902, we have in the first place to ascertain whether the second epidemic recurred on the same areas as were affected in 1900; and in order to judge this broadly, reference should be made to Diagram I.* On this 208 red spots have been placed which represent a corresponding number of adjudged places of infection in 1900; there are also 86 blue spots which represent the adjudged places of infection for 113 cases, in 1902.

40. It will be first noticed that red and blue spots are largely mixed together, and it will also be immediately perceived that on any hypothesis of spread, this must have been so to some extent, the reason being that while both sets of spots represent cases in man, the population among which they occurred was the same on both occasions, occupied the same area, and dwelt or worked in the same buildings; but on closer examination it will be found that large areas which carried many places of infection in 1900 were entirely spared in 1902. Secondly, when the individual premises are examined, it appears that out of the 286 houses which *harboured* (see par. 37) cases of plague in 1900, only eight again harboured cases in 1902. They were the following:—

1. Central Exchange Coffee Palace.—Case 135; cases 52, 53, and perhaps 2 others.
2. 47–51, Sussex-street.—Cases 2 and 29; case 42.
3. Her Majesty's Theatre and Hotel.—Cases 243 and 264; cases 18, 19, 20, 21, 33.
4. Criterion Theatre and Hotel.—Cases 227 and 236; cases 26, 27, 29, 31, 32, 39, 40.
5. Louden's Boot Factory, Elizabeth-street, Redfern.—Case 239; case 139.
6. Pier Hotel, Manly.—Case 257; case 110.
7. Saxton and Binn's Timber Wharf.—Cases 126 and 302; case 78.
8. 86, Windmill-street, Miller's Point.—Case 22; case 130.

41. The first 4 of these places were adjudged places of infection in both epidemics; the next 2 were so regarded in 1900 only, and the latter 2 in 1902 only. In 1900 the epizoötic extended to Manly, and there was a clear history of removal of dead rats by the patient, shortly before his attack, from the basement in which he was chiefly occupied. But in 1902 the most careful inquiry of the patient, who was a barmaid, and who apparently gave a full and straightforward account of her movements during the ten days which preceded her attack, entirely failed to reveal any probable source of her infection; the epizoötic having been ascertained as well as possible not to have extended to this waterside suburb on the latter occasion. As regards the last house mentioned in the above list it yielded in 1900 a single case of fulminant plague in a little girl; the house was old, and presented no signs of unusual infestation with rats. It was doubtful whether the patient had contracted the disease on the premises which, however, stood in the immediate neighbourhood of wharves in a locality largely occupied by warehouses, bonded stores, and the like places, and quite near to the lane in which the first case of that epidemic had occurred some two months earlier. In 1902 another little girl living in this house, but belonging to another family, was attacked; and, again, although the house yielded some evidence of infestation nothing definite nor, indeed, very suspicious, was discovered. But there was this slight difference in the known circumstances in 1902—a plague-rat had been collected on April 9th (the case occurred on May 15th) at Walker's Wharf, which was one of the line above which the house stood on a ridge. There was thus evidence of infection in the neighbourhood in 1902 which was wanting in 1900, though it may, nevertheless, well have been present then. Nothing of importance can be added concerning the 5th and 7th of the premises in the above list.

42. These 4 cases are, in my opinion, insufficient to raise a doubt; and the proper conclusion to be drawn from the whole number is that in those 4 most probably all the circumstances have not become known. The fact is that of

* Diagram I corresponds with diagram C attached to the Report, 1900; but whereas diagram C exhibited 255 spots, diagram I shows only 208. The main reason is that the spots on diagram C represented *cases*, but those on diagram I represent *places*; with the result that the number of spots then shown is reduced by 34. Besides this, diagram I does not cover quite as great an area as diagram C, and consequently 10 spots just to the east of its boundary, and 3 just to the south of it, are not shown; no cases having occurred in 1902 in the neighbourhoods thus indicated, nor beyond them.

of 6 premises which were adjudged places of infection in 1900, 4 were also adjudged places of infection in 1902. But the total adjudged places of infection in 1902 was 86; it follows that 80 of them were infected for the first time in 1902, while, on the other hand, 221 less 6 or 215 houses adjudged to have been places of infection in 1900 were spared in 1902: whence it is plain that the infection of 1900 showed no tendency to persist on individual premises. It will be noticed, also, that the 4 premises on which cases were adjudged to have been infected both in 1900 and in 1902, were used in ways known to be likely to attract rats to them.

43. It may be objected that so far cognisance has been taken only of premises in relation to cases in man, and that all of them were disinfected so effectually that the virus had no opportunity of establishing itself upon them. But the statement is that place-infection can also originate with introduction of infected rats to premises; now, although all those premises on which plague-rats were found were disinfected as carefully as though cases, too, had occurred upon them, yet it cannot be pretended that plague-rats were detected on all the premises which they had visited, or even where they had died. It might be supposed, therefore, that the 80 places of adjudged infection, apparently first made infective in 1902, may really represent that residuum of the many places which had been infected by plague-rats in 1900, which had then escaped disinfection, in which the virus had (*a*) succeeded in persisting, and in which (*b*) circumstances had secured its communication to man in 1902. To this, of course, no direct reply could be made. But after perusing the description of the mode of spread below, the reader will be in a position to judge how far the ascertained cause of the infectiveness of these houses in 1902 discounts the speculative supposition mentioned.

44. I conclude that there is no evidence of the occurrence at Sydney of place-infection in the Indian sense, and that the infectivity of premises in 1902 was due to the presence on them of the plague-rats of 1902.

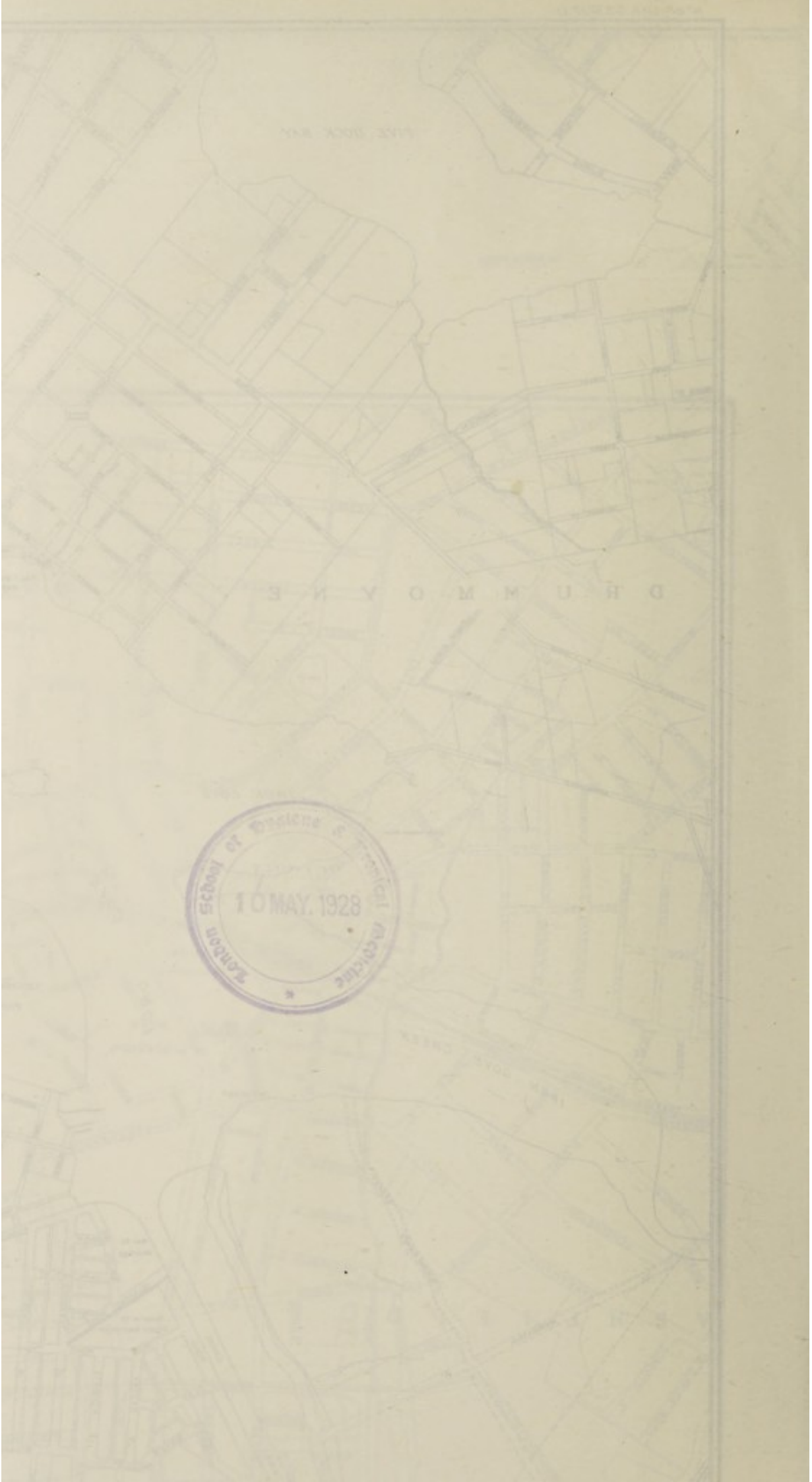
Cases in which the place of Infection remained undetermined.

45. From the total 139 cases, one, attacked on board the ship "Eulomene," may be excepted; it is fully described below. Of the remaining 138 the place of infection was determined in 113; and that number of cases were adjudged to have received the infection on 86 different premises. Remain, therefore, 25 cases in which the available information did not suffice to indicate any particular place as probably having been that at which the infection was taken. Two of the 25 were Chinese; 4 of them were idlers or prostitutes; 3 were labourers out of work, who were taken ill while searching for employment; 3 others were boys under 15; and 3 were either rat-catchers or scavengers in employment of the local authority for the City of Sydney, whose occupation led them into special danger at many different places. There remain 10 cases, therefore, in which it might be reasonably expected that the place of their infection would be discoverable. The history of each of them prior to attack was very carefully inquired into, and although nothing of apparent importance was elicited, the following data concerning some of them are worth mention. One was a druggist; one was a groom, who slept over a stable and in the same building with his horses'-feed; another was a clergyman actively occupied in district-visiting; another habitually gathered mill-wastes for poultry-feed at places on the Darling Harbour area (see page 31); another was an unemployed man, apparently not an idler, but whose movements were obscure. Other 3 were housewives, one was a waitress at a restaurant, and one a barmaid (see par. 41). Evidently many of these persons ran, or were likely to run, into danger in the course of their occupation or idle wanderings, at a time when plague was epizoötic and epidemic.

Origin of the Epidemic.

46. The only hypotheses worth serious examination, in our opinion, are the two following: Either the epidemic depended on a recrudescence of the epizoötic of 1900, or upon a second epizoötic set going by newly imported plague-rats. As to the former, we had reason to believe that the epizoötic of 1900 died out in the course of that year, but the evidence gathered was insufficient to establish the fact; still, the recurrence was apparently too long delayed to have been a recrudescence, the interval


PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH
MAP OF THE
CITY OF SYDNEY
AND
ADJACENT MUNICIPALITIES.
1903
COMPARING THE POSITION OF 208 ADJUDGED PLACES OF INFECTION IN 1900 WITH THAT OF 66 SUCH PLACES SEE PARAGRAPH 38 IN 1902, AND DISTINGUISHING 7 WHICH HARBOURED CASES IN BOTH THOSE YEARS.
EXPLANATORY NOTES
NOTE
DRUMMOYNE
BALMAIN
ANNANDALE
CAMPERDOWN
PARRAMATTA
WATERLOO
ALEXANDRIA
MARRICKVILLE
PETERSHAM
ASHFIELD
CITY OF SYDNEY
WOOLLOOMOOLOO
MOORE PARK



interval of fifteen months which elapsed before the disease again occurred having extended far beyond the time at which generations of new and susceptible rats had come into existence. Further, it will presently be shown that the state of rats as to disease was very carefully, and it is thought completely, ascertained over the whole of the threatened area from conclusion of the epidemic in June 1902, to 31st December, while from the latter date the wharfs were watched in the same thorough way until far into 1903. Now, the last plague-rat was discovered on 13th July, 1902; consequently there is good ground for asserting that the second epizoötic, at all events, died completely out: and therefore, as regards commencement of the second epizoötic, the balance of evidence at Sydney appears to tell in favour of reimportation. But this matter requires further observation in the field, and experiment in the laboratory, as the short table below concerning Western Australia pointedly suggests.

47. As to reimportation, Sydney remained in the communication by sea with all those ports in other parts of the world at which plague existed between August 1900 and November 1901, which was described before, (Report, 1900, p. 21), ports in New Caledonia alone excepted; but to them must be added some danger from two States of the Commonwealth, namely Western Australia and Queensland. The facts as regard Western Australia are shown in the table below:—

TABLE VII.—Showing the dates on which successive outbreaks of Plague in the State of Western Australia began and ended.

Year.	Number of Cases.	Locality.	Duration.
1900	6	Fremantle ...	April 5—June 18.
1901	23	Perth, Fremantle, and Kalgoorlie ...	March 1—May 11.*
1902	3	Fremantle ...	May 19—July 4.
1903	9	Fremantle ...	January 26—May 24.

* The cases occurred at Perth and in its suburbs for the most part; 2 at Fremantle, probably of local origin; and 1 at Kalgoorlie, a very distant place, thought also to have been infected at Perth.

Fremantle, at the mouth of the Swan River (population 16,367) is the port of Perth, which lies 12 miles higher up. Vessels coming foreign berth alongside; they do not ascend the river, but goods are carried up on lighters.

48. The important facts as regards Queensland were as follows in 1901:—

TABLE VIII.—Showing the cases of plague in rats and in man at Brisbane during the latter half of 1901.

	Cases in—	
	Rats.	Man.
July	20	3
August	8	1
September	1	.....
October	.....	1
November	1	.....
December	.....	1

49. One case was also reported from Bundaberg, Q., on 17th April, and one from Cairns, Q., on 16th July, both of which are seaports. Thus prior to November, 1901, the port of Sydney was in danger of importing plague-rats from Queensland, with which it is in daily communication by sea (by rail also with Brisbane), and perhaps also from Fremantle, though this seems uncertain. Precautionary measures were taken against this danger both at the distant ports mentioned and at this port, but these, as has already been pointed out (Report 1900, p. 44), cannot be relied upon invariably to prevent it. And it will be seen below that the rat-staff organised as soon as occurrence of Case 1 became known did on the second day of search (18th November) take a plague-rat at Howard Smith & Co's. Brisbane wharf; this being one of a line of wharfs, on the eastern side of Darling Harbour, at which produce is habitually landed, and the case having occurred at a produce store in the city which was distant from it. Nevertheless we are not at liberty to assume without reserve that the infection was brought hither either from Queensland or from Western Australia; for a vessel which has received plague-rats at a very distant port has arrived at Sydney after

after a voyage at sea which had lasted so long as 29 days with some rats still alive, and actually suffering from plague at the time of her arrival. This occurrence was observed in March 1901, and was as follows:—

THE CASE OF THE S.S. "ANTILLIAN."

50. The chartered troopship "Antillian," a steam vessel of 3,686 tons, entered Sydney Harbour, March 2nd, 1901, and brought to at the Boarding Station. She had left Capetown, February 1st, and presented a clean bill of health issued to her at that port. She was completely fitted for carrying mounted troops, had shingle ballast, a crew of sixty-five persons all told, no cargo, and no passengers. On being boarded by the Port Health Officer (Dr. W. Peirce, M.D.) all hands were reported well except an A.B., who was thought (there was no surgeon on board) to be suffering from pleurisy. Information having reached the Department of the occurrence of plague at Capetown subsequent to departure thence of the "Antillian," the ship was at once placed under fumigation with burning sulphur, and the case of the sick sailor reported. Dr. W. G. Armstrong, M.B., D.P.H. M.O.H., for the combined Metropolitan Districts, was directed to visit the patient; he diagnosed plague (Case I). The vessel was sent to the Maritime Quarantine Station, and the patient was at once transferred to hospital; at the same time inoculation was offered to all hands, but only ten (mostly officers) accepted, though at later dates a few more were done.

51. The following account of Case I, prior to March 2nd, was taken from the ship's log; the remainder was furnished by Dr. Armstrong:—

Case I.—O. O., Norwegian, aged 19; a deck hand, not inoculated; spoke very little English; was reported to have been quite well until—

February 27th.—Complained of frontal headache and chilliness; he vomited several times after taking a little food, but had no persistent vomiting. At 4 p.m., temperature 101°; began to feel pain in right axilla during the evening; took aperient medicine, which acted freely.

February 28th.—8 a.m., temperature 99·2°; midday, 101°; 8 p.m., 103°. There was a swelling in the axilla which increased in size during this day.

March 1st.—8 a.m., temperature 100°; midday, 101°; 8 p.m., 103°. The swelling was poulticed.

March 2nd.—Was found lying in his bunk in the forecastle. Face flushed, conjunctivae injected; tongue slightly furred; temperature 101·8°, p. 120, merely febrile in character and without tendency to dicrotism. There is a large œdematous swelling in the right axilla, which extends downwards to about six inches below the anterior fold of the axilla, along the wall of the chest. In the upper and anterior part of the swelling is a well-defined hardness about the size of a walnut, situated beneath the *pectoralis major*. The whole of the swelling is very tender, but the hard portion especially so. The lymphatic gland above the inner condyle of the right humerus is swollen to the size of a hazelnut, reddened and tender. An enlarged and tender gland can be felt below the angle of the jaw on both sides. There are neither wounds nor excoriations on the right side of the body.

March 3rd.—Died during the afternoon.

52. On *March 2nd* Dr. Armstrong, after disinfecting the skin thoroughly, abstracted liquid with a sterile hypodermic needle from the deep hardened area in the axillary swelling, and from the enlarged supratrochlear gland. At the laboratory this was subjected to microscopical, cultural, and inoculation tests of exactly the same kind as those already fully described (Report, 1900, Appendix A). It was found to contain numerous bacilli easily recognisable as *b. pestis*; and they proved fatally and characteristically pathogenic for two guineapigs into which some of the liquid was injected.

53. The following account of a second case has been abstracted from the clinical record kept by Dr. A. E. Salter, in medical charge of the Quarantine Station:—

Case II.—W. J. W., aet. 23, storekeeper; not inoculated. During the night of *March 11th–12th* felt some stiffness or soreness about the right groin, which he supposed was due to strain.

March 12th.—On examination, one gland of the left femoral chain was found to be enlarged, hard, tender, and distinct; temperature normal; no constitutional symptoms. Has had several attacks of malarial fever during past years. Isolated for observation.

March 13th.—Had been delirious during the night, and had not slept. State of the enlarged gland unchanged; no periadenitic effusion. Temperature, 103°; pulse, 104; respiration, 28. Transferred to hospital. At midday 60 cc. of Yersin serum were injected subcutaneously; 40 cc. in the left, and 20 cc. in the right thigh. At 1·45 p.m. had a rigor; temperature, 107°. At 8·45 p.m. an attempt was made to inject 40 cc. of serum into the right median basilic vein, but only 10 cc. could be made to enter; the remainder was injected under the skin of the right flank. On this date the patient was visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), and by Dr. Armstrong. Smears were made, and culture tubes inoculated, with liquid withdrawn from the bubo; the former showed a pleomorphic bacillus in large numbers which resembled *b. pestis*, while the latter

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in due course yielded pure cultivations of *b. pestis*. It was not thought necessary to apply any inoculation test to this bacillus, the clinical features of the case and the surrounding circumstances having already rendered the nature of the illness certain.

March 14th.—Had slept fairly well. Temperature, 99·8° morning, rising to 103° evening; eyes suffused; severe headache. At 10 a.m. 40 cc. of Yersin serum were injected under the skin of the right thigh; at 5 p.m. 40 cc. under skin of left calf.

March 15th.—Had slept better; urine offensive; bubo very painful; morning temperature, 99°; rising to 102·4° at night.

March 21st.—Has progressed favourably during the past week. On this date a profuse urticarial rash appeared, attended with much itching, &c.; temperature rose to 103·4°. The bubo was incised, giving exit to from 8 to 10 cc. of lumpy pus, and revealing a deep but not extensive cavity.

March 22nd.—The rash and irritation continue; very little discharge from bubo; was delirous all night.

March 31st.—A slough was discharged from the bubo; entered on convalescence.

54. On March 2nd Dr. Armstrong secured and carried to the Laboratories the putrid carcase of a rat (No. 1) found on board the "Antillian." On the whole this turned out to be too much decomposed for profitable examination; however, smears made from the inguinal glands revealed a bacillus resembling *b. pestis*, but cultures made from them and from other organs became overgrown in eighteen hours. On March 4th, the bodies of two more rats, which had been found dead on the "Antillian," were received.

55. Rat No. 2.—The skin showed very numerous petechial hæmorrhages, the abdominal cavity was full of blood-stained liquid; the liver was enlarged, soft, and full of punctate hæmorrhages; the spleen was enlarged, congested, and necrosed in one or two rather large patches; there were hæmorrhages in the kidneys and adrenals; the lungs were inflamed and blood-full. Smear preparations made from liver, lungs, spleen, and inguinal glands teemed with *b. pestis*, and pure cultures were recovered from all these organs. A guinea-pig inoculated in the right thigh with material from the liver of rat No. 2 died in seven days, and presented the appearances usual in inoculated plague; smear preparations made from its various organs revealed *b. pestis* in profusion, and pure cultures of *b. pestis* were recovered from the latter.

56. Rat No. 3.—The body of this animal presented exactly the same appearances as have been described above of rat No. 2, and direct and cultural tests yielded similar results. No inoculation tests were made, the nature of the disease being already unmistakable.

57. The master of the "Antillian," who took a lively and intelligent interest in the infection of his vessel, said that there were not many rats on board; but that, on the day of departure from Albany (February 22nd), some unusual, though not great, mortality was discovered among them in the course of cleansing operations, about fifteen carcases having been found and thrown overboard. He also said there were several good ratting cats on board, and that whereas these cats had occasionally brought rats they had caught to the bridge for inspection, after the above-mentioned mortality had been noticed they caught (or, at all events, exhibited) no more.

58. After leaving Albany all the deck hands (sixteen) except the quartermasters were employed in cleansing the holds under supervision of the mate and the boatswain; the log showed that all hands had been thus employed on February 22nd, 23rd, 25th, and 26th, but the work was continued in some degree almost until Sydney was reached (March 2nd). It was during these operations that the fifteen dead rats mentioned above were found. The sailors would not touch them—not because any danger was apprehended, it was said, but because they thought it was "not their work" to handle dead rats—and they were thrown overboard by the mate and the boatswain (neither of whom fell ill). O. O. was one of the sixteen deck hands, and was employed with them on the work just mentioned.

59. It has been mentioned already that the "Antillian" arrived completely fitted for carrying mounted troops, without any cargo or fodder, and in shingle ballast. But she brought a quite small quantity of food stores—biscuits, tea, confectionery, sugar, flour, &c., &c., all of which except 7 tons was securely cased. These stores were in charge of W. J. W., Case II, and they were stowed on the orlop deck in the most forward of the five compartments into which the hull was divided by water-tight and fixed bulk-heads. Below this part of the orlop deck a small

small quantity of dried potatoes was stowed, but the other stores mentioned were parcelled out among several rooms temporarily constructed on the orlop deck. During the cleansing already mentioned these store-rooms were not touched.

60. The ship brought a clean bill of health issued to her at Capetown, and in answer to the usual questions her Master stated that neither plague nor any other epidemical disease existed there at the date of his departure (February 1st). But on February 12th news had reached the Department of the occurrence of plague in man at Capetown, two cases having been reported under date February 9th, and on the same date it was also reported that the dock rats had migrated from the South Arm of Capetown docks and had made their way to Green Point Camp. In view of these reports the "Antillian" had been placed under fumigation with sulphur almost immediately on arrival, and before the nature of O.O.'s illness was suspected. After the latter had been clinically recognised she was submitted to a second fumigation, which began on March 3rd, and continued till the morning of March 4th. Neither of these fumigations can have much affected the store-rooms, since these were separately built up within the forward compartment. On March 5th the store-rooms were inspected preliminary to directing special disinfection, and the carcases of one putrid and one desiccated rat were then found. The rooms and their contents were thoroughly sprayed with sublimate solution 1-500 by the Quarantine staff, and afterwards were fumigated with burning sulphur. On March 9th, the stores were transferred to a lighter under superintendence of W. J. W., Case II (when ten more carcases were found), so that the rooms might be more thoroughly cleaned; and this having been done, they were replaced on March 11th—again, under supervision of W. J. W. The latter, who had not been on board except on the dates mentioned, fell ill during the night of March 11th-12th; it is, therefore, most probable that he was infected on March 8th, during removal of the stores, this having been the third day before attack. Several other persons were engaged in this work, none of whom fell ill.

61. The previous history of the "Antillian" was compiled from the ship's logs, and was as follows. The "Antillian" left Southampton towards the end of 1899, and arrived at Capetown during the month of December. She remained on the South African Coast about seven months, going backwards and forwards between Capetown and Durban; she lay in the stream at the latter port, and usually lay alongside at Capetown. On July 23rd, 1900, she left Capetown for Hongkong, *via* Singapore. She reached Hongkong August 22nd, 1900, and lay in the stream; she discharged ammunition and received coal and stores, but did not go alongside there. On August 26th, 1900, she left Hongkong for Wei-hai-wei, where she arrived August 30th; she lay in the stream. She left Wei-hai-wei October 26th, 1900, and arrived at Woosung, October 28th; left Woosung, October 29th, and arrived at Hongkong November 1st. She lay in the stream at first, but afterwards went into dock at Kowloon. She left the latter berth and cleared for Durban on November 7th, 1900. Her further history is tabulated below:—

Left.	*Arrived.*
1900.	1900.
Kowloon Dock, November 7th	Durban, December 3rd; lay in the stream.
Durban, December 7th.....	Capetown, December 10th; lay alongside at South Arm.
South Arm, December 14th.....	Graving Dock, December 14th.
Graving Dock, December 21st..... ..	Coaling Wharf, December 21st.
Coaling Wharf, December 24th	Anchorage in stream, December 24th.
Anchorage in stream, December 27th ...	South Arm, December 27th; lay alongside.
1901.	1901.
South Arm, January 4th	Anchorage in stream, January 4th.
Anchorage in stream, January 11th	South Arm, January 11th; lay alongside.
South Arm, January 12th	Port Elizabeth, January 14th; anchored in stream.
Port Elizabeth, January 14th.....	East London, January 15th.
East London, January 16th.....	Durban, January 17th; anchored in stream.
Durban, January 19th	Capetown, January 23rd; anchored in stream.
Anchorage in stream, January 29th	South Arm, January 29th; lay outside the s.s. "Jeanit e North," across which vessel traffic with the shore was carried on.
South Arm, January 31st	Coaling Wharf, January 31st.
Coaling Wharf, February 1st	South Arm, February 1st; lay alongside.
South Arm, February 1st	Albany, W.A., February 20th; anchored in stream; took coal from a lighter.
Albany, February 22nd	Sydney, March 2nd; was arrested at the Boarding-station.

62. There is no reason for referring further to any of the ports touched by the "Antillian" during the fourteen or fifteen months which preceded the date of her departure from Capetown for Australia; there is an apparent possibility of her having acquired the infection of plague, but nothing occurred during her second term of service on the South African coast (of three months) to raise a suspicion that she actually had done so. On the other hand, although at the date she left Capetown that port was not known to be infected with plague, remarks published by the Director of the Bacteriological Institute, Cape Colony (Dr. A. Edington),* leave no room for doubt that the rats infesting the South Arm of the Capetown docks had been dying of some epizoötic disease before February 5th; and, since the prevalence of disease among them had become known by that date at latest, it is almost certain that they had begun to suffer at least a fortnight or three weeks before. Now, from the log of the "Antillian" it appears that this vessel had lain alongside at South Arm during 1901 on January 11th, January 20th, and February 1st.†

63. The "Antillian" lay at Albany for twenty-four hours on February 21st and 22nd; she anchored in the stream, and received coal from a lighter which came alongside. As plague has occurred in Western Australia it is necessary to point out that the first case in that State in 1901 (but see Table VII, p. 11) was notified on March 1st, and was that of a man who had died at Perth—that is to say, this death occurred five or six days after the "Antillian" had left Albany. The latter is not near Perth; it is a small town on King George's Sound where there is an excellent harbour, and lies 245 miles south-east of Perth, with which, however, it is connected by rail. Other cases subsequently occurred at Perth, and more at some other towns; but no suspicion of plague has ever attached to Albany either in its people or in its rats; it has already been noted above that mortality among the ship's rats was discovered on the day of departure from this port.

64. The "Antillian" was returned to service 13 days after her arrest‡; and 35 days after arrest sailed for Capetown, carrying 527 troops and their horses. No suspicious illness occurred on the voyage. She is the only vessel entering the port of Sydney on which either plague-rats or cases of plague in man have been discovered.‡

65. But the mode in which plague is diffused by sea is not always as clearly demonstrable as in the foregoing instance; and this the following case well exemplifies.

The Case of the Barque "Eulomene" (Case 72).

66. The four-masted barque "Eulomene" left Liverpool October 12th, 1901, carrying a crew of 34, and a general cargo. She arrived at Sydney January 15th, 1902 (Case 4), and reported one death from dropsy during the voyage; she was admitted to pratique the same day. She lay in the stream until January 21st, when she went alongside Federal Wharf and discharged cargo; 800 tons, consigned to Newcastle, were retained on board. On February 26th she left Federal Wharf and lay in the stream till March 6th (Case 49).

67. Rats from Federal Wharf had been examined in the laboratories on November 22nd and 23rd, and from Federal Bond on November 23rd, 25th, 26th, and 28th, 1901; between March 5th and April 15th, 1902, 186 rats were collected on the wharf on 25 days, of which 45 were examined in the laboratories; in all cases the result was negative, and there was no history of unusual mortality among the rats at this wharf.

68.

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* The *Lancet*, June 8th, 1901.

† It is necessary to note here that Dr. Edington did not succeed in collecting any rats at South Arm docks for six days after the search commenced; that the carcase of a rat which had recently died was delivered to him on the seventh day; that he found that this rat had died of an infective disease; and that while he was unable to name this disease he considered it was not plague. Manifestly little importance attaches to this failure to identify disease in a single carcase.

‡ Contrary statements contained in the Local Government Board's "Reports and Papers on Bubonic Plague, 1902," are erroneous.

68. On March 6th, before her departure for Newcastle, the vessel was handed over to the Fumigating Staff, under Captain Tait, in accordance with the Order in Council of November 21st, 1901; it was subsequently reported that this fumigation was very thorough, and that after being detained not less than six hours under sulphur, she had sailed. The hatches were opened at sea, and the holds were searched for dead rats as soon as they could be entered by the crew; the Master said that many fresh carcases were found, as well as some rats which were alive, but stupefied; altogether about 40 were thrown overboard. On arrival at Newcastle, on March 7th, the "Eulomene" went straight to the Dyke and shipped 500 tons of coal; on March 8th she went alongside at Queen's Wharf and discharged the 800 tons of cargo; she left Queen's Wharf March 20th and made fast to No. 1 Dolphin, Stockton.

69. On March 17th (or ten days after arrival) F. J., 43, ship's steward, was taken ill, and was attended on board by a private practitioner, under whose direction he was removed to the general hospital on shore. On March 19th his case was reported as suspicious, and the Medical Officer of Health for the Hunter River Combined Districts (Dr. Robert Dick, M.B., D.P.H.) was directed to examine him. On the 20th Dr. Dick reported that smears made with liquid withdrawn from the right axillary bubo which the patient exhibited showed a few micro-organisms resembling *b. pestis*, and that agar-tubes inoculated with the same liquid had yielded pure cultures of *b. pestis*, after 24 hours' incubation; he subsequently further reported that a guinea-pig inoculated with the liquid had died of plague, as ascertained by the usual processes. These results, at Dr. Dick's request, were checked, as far as possible, and were confirmed, in the Departmental laboratories.

70. The Port Health Officer (Dr. R. U. Russell) was at once directed to place the vessel in quarantine, and to cause her crew (who on her arrival at Newcastle numbered 22) to be collected on board with assistance of the Water Police; on the 21st she hauled off into the stream. A further fumigation with sulphur was carried out, and a very thorough search for rats afterwards made by the Quarantine Staff, under Dr. Russell's supervision. About 20 desiccated carcases were found, but only two recently dead rats and one mouse; the latter were examined by Dr. Dick and furnished no evidence of plague. All on board remained in good health, and after 5 days detention the "Eulomene" was admitted to pratique. At the same time the 800 tons of cargo landed at Newcastle were traced to various bonds and stores, some in towns at a considerable distance; they consisted of cases of hardware, crates and casks of earthenware, cases of whisky and beer, bales of paper and of other such goods, many of which were likely to harbour rats. It was found that some of these packages had been opened already; others were opened with precautions, under supervision, but it was reported that no rats were found in any instance.

71. In the meantime the patient had been removed from the general hospital to the Maritime Quarantine Station at Stockton. His illness was not very severe, and he was able to give the following information which, on the whole, was corroborated by enquiry of the Master and some members of the crew. He said that while the ship lay at Sydney fresh meat and vegetables were furnished by a ship's butcher in Erskine-street. A bag or two of potatoes were supplied at a time, and were kept on board in his store; on several occasions, on putting his hand into the bags, he encountered rats which were stupid or sluggish, so that he had had no difficulty in destroying them, and had not been bitten by them. He said he had thus found 6 rats at least, on different occasions, and for the last time some few days before leaving Sydney. On being questioned the butcher admitted that he had got some of the potatoes at all events (he was reluctant to furnish information) from a produce salesman trading at Nos. 61-63 Sussex-street. At this store no plague rats had been found, and no case of plague had occurred; but at No. 41 (ten doors away) plague rats were got on February 18, 19, and 20; at the Union Company's wharf on February 19; at the North Coast Co.'s wharf on February 25; dead rats had been seen by officers of the Department at Campbell's produce store, 49-51 Sussex-street, and Case 42 occurred in a man employed there as a carter, who was attacked February 27; and plague rats had been got from Huddart, Parker, and Co.'s wharf on February 28: all of these premises being close together on the same side

side of Sussex-street—that is to say, on the eastern side of Darling Harbour—as the premises of the produce salesman who sold the potatoes to the ship-butcher, who supplied them to the "Eulomene" while she lay at Sydney.

72. The above are the facts of this case, as far as they could be ascertained; they must not be taken for more than they are worth. For instance, it is quite possible that at some time or other before March 5, during the "Eulomene's" stay there, the Federal Wharf may have harboured plague rats, of which specimens were secured from other wharves at no great distance. The ship's rats may also have become infected during her long stay at a wharf in an infected neighbourhood in other ways, as exemplified by the steward's account, which latter seemed trustworthy as regarded the important points. Secondly, after the first fumigation at Newcastle, twenty desiccated carcases of rats were found. Now these carcases hardly could have been killed by the first fumigation (March 6), because the interval between it and the date on which they were discovered (March 22) was not long enough for desiccation, or, as it was described, mummification. Did these desiccated carcases represent the result of a foregoing epizoötic which occurred while the ship lay at Sydney, or did they represent merely the turning out of gradually accumulated carcases from parts of the ship rarely cleansed? There is no reason to doubt that the two rats and one mouse found after the second fumigation represented all that the ship then carried alive; both the fumigation and the subsequent search were most thoroughly carried out, and the result was accepted as proof that she was not then infected, so that she was forthwith released from quarantine. The fact that one only of the twenty-three persons on board was attacked is not evidence that the vessel had not been the subject of general infection; our experience has shown that when the infection is present, as proved by the occurrence of one case, very often no further cases occur. But the one person infected in this instance was the steward, and according to his account he had been specially exposed. Was he infected directly from the sick rats he took out of the potato bags? This cannot have been the case, because he was not attacked until ten days after he had left Sydney, and the last occasion on which he had caught a rat was several days, as he said, before leaving. For similar reasons he cannot have been otherwise infected at Sydney, for he had not been ashore there for nine days before he arrived at Newcastle, or nineteen days before his attack; and he was not infected on shore during his stay at Newcastle, because there had never been plague there, and the solitary case which afterwards occurred under circumstances which require separate description, was not attacked until August 7, or about five months afterwards (see page 49). He must have been infected on board his ship; and, as he exhibited a bubo, he was infected by inoculation; that being so, it is unlikely that he received the infection earlier than March 14, or three days before his attack. Whence was he inoculated? The choice seems to lie between contact with deposited infection and inoculation by a parasite. As to the first, the infection might possibly have been deposited by the sick rats he caught; but in that case it must have survived in virulent form for ten days at the least, or for about fifteen days (namely, from the date of the ship's departure from Sydney, or from that date a few days earlier on which he had seen the last of the sick rats); besides which the cuticle of the extremity had not recently been broken (see Further Observations on the Mode of Infection, p. 65). Certainty cannot be reached—I may almost add, of course; for although epidemiological problems are resolved by induction from collected cases, it often happens to be impossible to show that a particular instance exemplifies the solution. I conclude, therefore, by pointing out that these notes suggest an analogy with certain occurrences of yellow fever on board ships.

73. The "Eulomene" sailed from Newcastle for San Francisco, where she arrived July 24. A rumour was heard that her master was ill on arrival, and subsequently died, of plague. By favour of the United States Consul the Medical Officer of Health received a copy of a report made on the case to Surgeon-General Wyman, Public Health and Marine Hospital Service of the United States, in which it was clearly shown that the disease was beri-beri, and that there had not been any suspicious illness of any character during the voyage of the vessel to that port.

Part II.—Mode of Spread.

Subdivision of the affected district into Areas.

74. I now enter on a description of the mode in which the epidemic spread. This has been designed so as to place the reader in the same position as those who watched the events as they occurred from day to day, as far as possible; and, in order to make it more easy to grasp, the parts of the city in which indigenous cases of plague were met with have been divided into areas, to which the following names have been given (see Diagram II) :—

Area.	Area.	Area.
South-central.	Central.	North-central.
Paddington.	Darling Harbour.	South-west-central.
Chippendale.	Woolloomooloo.	South-east-central.
Alexandria and Waterloo.	Camperdown.	Pyrmont.

75. As a rule, the description of the epidemic on each area dealt with has been completed, a plan which has obvious drawbacks; but the alternative, which is to describe the cases in their time-relation, could lead to nothing but confusion, and may be dismissed as impracticable. The description of the South-central area alone has been interrupted to admit that of the sub-epidemic on the Paddington area. No "area" has been assigned to 4 isolated cases which are adjudged to have been infected at 4 widely separated places.

76. To describe all the cases, and even all the areas, would involve a good deal of repetition owing to general similarity of the facts; some have therefore been selected. They constitute a large majority; but, in an inquiry of this kind, it is important that the reader should have some means of judging whether anything of real importance has been omitted. For this reason a Table has been inserted in the Appendix, in which every case is mentioned under its serial number, and a reference given to some of the paragraphs in which those which have been described may be found. This Table also shows the date of attack in each case, the 86 adjudged places of infection for 113 of them (that is to say, the number which remains after 1 case excepted, and 25 cases in which the place of infection remained undetermined, have been deducted from the 139 cases in which the epidemic consisted), and the area within which 82 of those places stood (see par. 75, end).

South-central Area.

77. The following Table shows the cases which occurred on this area :—

Table IX.—Showing the serial number, date of attack, adjudged place of infection, and residence of the 8 cases which occurred on the South-central Area.

Serial No.	Date of attack.	Adjudged place of infection.	Residence.
1	Nov. 4, 1901 ..	Exton's Store, Hay-street ...	Alexandria.
4	Jan. 12, 1902 ..	285, Castlereagh-street ...	The same.
16	Feb. 9, 1902 ...	376, Pitt-street	,,
93	April 3, 1902 ..	137, Liverpool-street	Marrickville.
112	,, 27, 1902 ...	26, Campbell-street	The same.
113	,, 30, 1902 ...	59, Goulburn-street	,,
117	May 3, 1902 ...	26, Campbell-street	,,
126	,, 15, 1902 ..	26, Campbell-street	,,

Case 1.

"DIAGRAM II"


PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH
MAP OF THE
CITY OF SYDNEY
AND
ADJACENT MUNICIPALITIES.
1903
THIS DIAGRAM SHOWS THE ADJUDGED PLACES OF INFECTION FOR 103 CASES OF PLAGUE, BY BIG BLUE SPOTS. IT ALSO SHOWS THE MILITARY BOUNDARIES OF THE AREAS WHICH, FOR CONVENIENCE OF DESCRIPTION, HAVE BEEN ASSIGNED TO THE DIFFERENT NEIGHBOURHOODS IN WHICH THOSE PLACES STAND, BY BROAD BLUE LINES.
DRUMMOYNE
NORTH CENTRAL AREA
DARLING
CENTRAL
HARBOUR
AREA
SOUTH WEST
CENTRAL
GLEBE
ANNANDALE
PETERSHAM
CAMPERDOWN
DARLINGTON
ALEXANDRIA
WATERLOO
MARRICKVILLE


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Case 1.—R.B., m., aged 17, not inoculated, was suddenly attacked with headache and rigors after reaching his place of employment on the morning of 4th November, 1901. He immediately returned to his residence, and lay there under care of his club surgeon until 8th November; he was then transferred to Prince Alfred Hospital. His case was reported to the Department on 14th November; he was visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), and was removed to isolation the same day. His removal was determined by purely clinical considerations, for the morphological test which was applied to liquid abstracted from the right femoral bubo he exhibited failed to reveal the bacillus of plague; but the cultural and inoculation tests which were begun at the same time yielded positive results in due course. Ultimately the patient recovered.

78. R.B. resided with his family of 6 persons in a two-storied brick cottage at Alexandria, some 2 miles away from his place of employment. These premises were very carefully examined on the day his case was reported, but nothing of importance was discovered; they were in fair general repair, maintained in average good order, and furnished no evidence at all of infestation with rats. No illness occurred among the rest of the household. He was employed, along with three other men, at a produce store in Hay-street, in the City of Sydney, which will be further referred to as "Exton's store," and these premises were also examined as soon as attention had been directed to them by his case. They were found to be one of 13 houses on the frontages of a very small block which was occupied in large proportion by gasometers, the extensive and lofty building of a "universal provider," and a church. Eleven of them were used as produce stores, one was a seedsman's, and one a small hardware store; that is to say, they were chiefly used in ways most likely to attract rats to them. They had behind them a small common yard, in which four of these traders, who were Chinese, had erected stables and feed-rooms. Exton's premises were in fairly good repair, but offered abundant evidence of infestation with rats; and on raising the wooden floor 69 carcases were found. Of these 68 were too putrid for any useful examination, but one was quite fresh; it afforded the usual microscopical, cultural, and inoculation evidence of plague. This animal, then, had lately died of plague; and it is a very reasonable assumption that the other 68 had also died of that disease at somewhat earlier dates. No case of plague occurred among R. B.'s 3 fellow-labourers at the store, and none was heard of among the persons who had frequented it, for no further case came to notice during the ensuing 5 weeks.

79. The cleansing-staff immediately went through the block, and in the course of their work discovered 18 more putrid carcases. These are said to have been found outside buildings, for the most part, at least, but no note on this point was made at the time. No other of these houses, however, afforded evidence either of such infestation as was discovered at Exton's, or of any unusual mortality. There are here three noteworthy points: Our general experience as far as it has gone shows that only a moderate or even small proportion of adjacent premises may be infested with rats (apart from question of plague) although from their structural state and use nearly all of them appear equally likely to be so; of which a further and detailed instance will be given below. Further, it appears that often the epizoötic is largely confined to the rats inhabiting particular premises, and at any one time probably affects but a small proportion of the total rats in the district. Secondly, from both epidemics we have evidence of establishment of centres of infection by a mode of transportation from the local *fons et origo* which does not cause infection of the traversed interval, and of slow and irregular spread of the epizoötic from them; while many adjacent buildings might at the same time harbour a plague-stricken horde, on the whole this appears to be seldom the case. Lastly, it will be observed that but one carcase was found which was in a state to admit of its bacteriological examination; all the others were advanced in putrefaction. Our general experience is that while dead rats are often found in a number which indicates some unusual cause of the mortality on premises to which attention has been directed by occurrence of a case of plague in man, it is quite unusual to find them early enough to allow of demonstration of the nature of the disease of which they have died. We have been led by observation to consider that discovery of several carcases at about the same stage of putrefaction on premises where poison has not been laid, is good evidence of disease in epizoötic form.

80. Efforts were also made at once to ascertain the provenance of Exton's stock, and steps were taken to re-organise a rat-catching staff. As to the former, it was said that some of it came in by rail from country districts in this State where, of course,

course, there was no plague; but the greater part came in by sea, and was landed at the wharfs where this trade is chiefly carried on, those, namely, on the eastern shore of Darling Harbour. This portion chiefly arrived from South Australia, Tasmania, &c., &c., and it was said that none had been received by him from Queensland.

81. The rat-catchers got to work on 10th November, and on 17th November they made their first return. They were instructed to attach the addresses at which they had caught the rats to the carcases, and to hand them in to a foreman, who recorded them, each morning. This staff was further instructed to forward to the laboratory the bodies of all rats apparently sick on discovery, and the bodies of all which were gathered on premises where there had been unusual mortality among them. Carcases thus selected were examined in the laboratory; but the method of selection was imperfect. It was not until 1st April that all rats taken by this staff were handed in at the laboratory and systematically examined there.

82. The neighbourhoods in which the staff worked during the days now under notice were the line of wharves already mentioned, the buildings from the head of Darling Harbour towards Exton's store, from the latter westerly along George-street, and additionally along the line of that gutter or natural surface depression which ascends from George-street in a southerly direction to the Newtown-road. To speak for the present of the first 10 days of this search only, 1,657 rats were caught at 28 wharfs, and at 115 different premises, which included many produce stores, hotels, eating-houses, and provision shops, on or about the line above indicated; 117 were selected and were forwarded to the laboratory. Thus the rats on the area which there was most reason to suspect (in part from our former experience) were examined. It would have been better had all those caught been delivered at the laboratory; but it must be remembered that had this course been taken, the examination would not (and it never could) have amounted to more than a sampling—to examination, that is, of the rats in some of the innumerable houses which stood on the area referred to. Further, selection of the buildings visited was largely governed by willingness of the occupants to admit the rat-catchers at night.

83. On the second day (18th November) of the search a plague-rat was detected among those referred to the laboratory. It had been collected at Howard Smith & Co.'s wharfs, and at that one of them which is called the Brisbane Wharf (see par. 49), although it is understood not to be exclusively used by those vessels of this firm's fleet which trade between Sydney and Brisbane; they are wharves at which much grain and produce are handled, and adjoin those wharves at which Exton's stock in part was landed—the detected infection of this Brisbane wharf betokening, of course, probable infection of other wharfs in its immediate neighbourhood.

84. No other plague-rat was found until the ninth day of search (25th November). A second produce dealer, named Jones, then reported that the rats which infested his premises at 84, George-street West (about 45 chains westerly from Exton's) were dying in numbers. The store was at once closed and searched; no less than 154 carcases were discovered, and 35 living rats were killed. Here, it seems, the search was made quite early in the outbreak, and before the animals had recognised the expediency of leaving the premises; and it was easy to demonstrate that plague was the cause of the mortality. No case of plague occurred among the persons employed or living at this shop nor, it is believed, among those who must have frequented it. Then on the tenth day of search (November 26) a plague-rat was handed in by the Departmental staff, which had been taken on premises at the corner of Cleveland and Abercrombie streets, towards the head of the surface-depression already referred to, and about 22 chains southerly from Jones' store. They included a greengrocer's shop and a stable. There were abundant signs of recent infestation by rats in considerable number, but no carcases were discovered nor any live rats. It was noted that the premises were filthy, the yards being largely occupied by fowls, ducks, geese, and dogs. A ton of chaff, bones, and rat-rubbish was removed from under the floor of the feed-room, and the whole premises were in such a state of dilapidation that the Local Authority was required to apply for a closing order and for their demolition. No

case

case of plague occurred among the persons inhabiting these premises, nor among any casually connected with them as far as could be learned. No note was made as to the source at which horse-feed was procured; this may have been Jones' store, which was but a little over a quarter of a mile away.

85. Laboratory examination of rats continued in a manner which will be summarised and commented upon at a convenient place in this description, without revealing any others infected with plague, until the next case in man had occurred about five weeks later.

Case 2.—J.E.D., m., aged 37; had been inoculated at Rockhampton, Queensland, early in 1900 (see par. 28); married, four children. He was suddenly attacked on December 8, during the forenoon, with a sharp pain in the left groin, where femoral and inguinal glandular swellings subsequently developed. He lay ill at his residence in Spring-street, Waverley, about 3 miles away from his place of business and the other places hitherto mentioned, under private care until December 10, when his case was notified. The diagnosis was at once made from clinical signs; subsequently morphological, cultural, and inoculation tests all yielded positive results. His condition at the time of discovery forbade removal, and he died December 11 after an illness which had lasted sixty-five hours.

86. J.E.D. was a druggist's assistant. He had arrived from Rockhampton, Queensland, about two months before his death; no case of plague had been notified at Rockhampton for 10 months before his departure (or on 11th October, 1901); his wife said she had received a one pound note from her brother at Rockhampton since her arrival at Sydney, but that deceased had known nothing of it and had not seen it; the case of plague which was notified at Rockhampton next after the one just mentioned was ascribed to 11th February, 1903. His place of residence was in fair general order and repair; it stood in a suburb which has never yielded any other case, and it offered no traces at all of infestation with rats. The family of 6 persons, among whom no illness occurred, was entirely unacquainted with Case 1. He was employed by a firm of wholesale druggists at their premises in the city of Sydney. The firm said that poison had been laid ever since Case 1 had become known, and that 72 carcases had been found and destroyed. A good many more, in advanced stages of putrefaction, were afterwards turned out in course of cleansing, but no live rats were seen, and no evidence of plague was obtained. Such mortality from poison is quite unusual. There were here about 300 workmen, among whom no illness occurred. But D., regularly employed during the day at this establishment, was also employed in the evening by a benefit society, and on this duty he went to the dispensary, which stood in Castlereagh-street, at a point not more than 11 chains distant from Exton's store (Case 1). On examination the dispensary was found to be very well constructed, clean, and free from evidence of infestation with rats; and none of the subsequent cases of plague were traced to connection with it.

Evidence of Diffusion of the Infection.

87. The rat-search continued without revealing any plague-infection until after a further interval of thirty-five days. The third and fourth cases in man happened on January 10 or 11 and on January 12. The former was the first of a sub-epidemic which occurred on what has already been referred to as the Paddington area; the latter was found in the immediate neighbourhood of the dispensary building mentioned in connection with Case 2, and consequently on the South-central area. Cases 3 and 4, therefore, furnished the first clear evidence that the infection had become diffused. The sub-epidemic which followed on Case 3 afforded an unusually distinct (but far from solitary) example of transport of the infection over a considerable tract which either entirely escaped, or suffered only in part at a much later date and, plainly enough, from infection otherwise communicated to it; and I interrupt the account of the South-central area to describe it here, because it was altogether confined to a remote and circumscribed area, and furnishes a most useful type of the course of the epidemic as a whole.

The Paddington Sub-epidemic.

88. The table below shows the serial number, initials, sex, age, date of attack, and address of the patients whose cases constituted this sub-epidemic, as well as particulars concerning two undiagnosed cases which, I have little doubt, were also cases of plague. These latter are unnumbered (see Diagram III).

Table X.—Showing the serial numbers and dates of attack of the nine cases which constituted the Paddington sub epidemic, as well as of two undiagnosed cases connected with them:—

No.	Name.	Sex.	Age.	Date of Attack.	Address.
3	E.A.G. ...	F.	50	January 10 or 11 ...	145, New South Head Road.
...	G.B. ...	M.	35	„ 13 ...	18, South-street, New South Head Road.
...	J.E.G. ...	M.	69	„ 16 ...	35, Gurner-street, Paddington.
5	E.G. ...	F.	21	„ 16 ...	145, New South Head Road.
6	M.C. ...	F.	43	„ 19 ...	147, „ „
7	R.V. ...	F.	10	„ 19 ...	115, „ „
8	J.C. ...	F.	72	„ 20 ...	147, „ „
13	M.A. ...	F.	38	February 7 ...	163, „ „
14	J.H. ...	M.	59	„ 10 ...	192, Albion-street, Surry Hills.
16	J.G. ...	M.	24	„ 10 ...	312, Glenmore-road, New South Head Road.
17	P.B. ...	M.	12	„ 11 ...	217, New South Head Road.

89. These cases came to light in the following way: On 14th January, M. C. (Case 6), who at that date was in apparent good health, reported that rats were dying in numbers at her residence, 147, New South Head Road. Thereupon the rat staff was directed to secure specimens from her cottage and from its immediate neighbourhood. No rats were caught that night, but the rat-catchers reported that the rats were dying at No. 149 (next door) also; it was also mentioned that Nos. 145, 147, and 149 were one-storey brick cottages, identical in construction, and at a later date it was ascertained that the space under the floors of all three was continuous, and open to the rats which infested any one of them. No. 149 stood at the corner of Glenmore-road, and was occupied by R. Goff, junior, as a produce store. He said that the rats on his premises had been dying in numbers for about 10 days past (that is to say, from about 4th January). M. C. said she had seen sick, as well as dead, rats in her kitchen and laundry, and the occupants of all three cottages were at one in saying that although they had formerly been very much troubled with rats, none had been seen alive "for the past few days." On the morning of 16th January, the rat staff handed in one carcase which, on examination, was found to be free from disease; however, they had removed three carcases from the yard of No. 147, and one from No. 145, all too much decomposed for examination, and had noted an extremely offensive smell on all these premises, as though dead rats lay concealed. Lastly, when the premises came to be taken in hand by the disinfecting staff, on 20th January, it was found that, although there were everywhere abundant traces of infestation with rats, there were none pointing to their quite recent presence (fresh dung). Ultimately no plague-rats were taken on these premises, and none were collected from any part of the infected area until many days afterwards.

90. Illness among the inhabitants of these three cottages was first discovered through report, on 19th January, that M. C. (Case 6) was lying ill at No. 147. It was then found that E. A. G. (Case 3) had been attacked eight or nine days earlier, and had been lying in bed at No. 145 in consequence, at the time the rat-search was going on. Comparative mildness of her illness (which, nevertheless, had compelled her to take to bed and to stay there) led to its having been thus concealed, or, rather, not mentioned. E. A. G. (Case 3), having been seized, on 10th or 11th January, E. G. (Case 5), in the same house, was attacked on 16th January, and M. C. (Case 6), in the cottage next door, on the day of notification, 19th January. R. V. (Case 7), who lived fifteen doors away, at No. 115, was attacked on the same date, and J. C. (Case 8) was attacked at No. 147, on 20th January. But there had been two other deaths in connection with these premises, which I have little hesitation in ascribing to plague, although this disease was not recognised as the cause at the time they occurred. The facts were as follows:—

Undiagnosed Case A.—J. E. Goff, senior, age 69, labourer. Was father of J. Goff, of 149, New South Head Road, and regularly worked at the produce store. He resided at a considerable distance away, in a plague-free neighbourhood. He arrived at the store at his usual hour on January 16, having been

been in good health until that date, but complained of feeling unwell; about 10 a.m. his son took him home, and two hours later he died. By direction of the Coroner, his body was inspected by a medical man, who reported that his death was due to syncope from heart disease. I ascertained that this opinion was based on a statement made by deceased's family that he had latterly been breathless on slight exertion, and on observation of slight œdema about the ankles; further, the gentleman referred to, who had both clinical and *post-mortem* experience of plague during the former epidemic, said he thought he could hardly have overlooked the signs of that disease had any of them been present. This may be readily conceded; and yet it appears to me probable that plague in one of its less usual, but not uncommon forms, in which all external signs are wanting, may have been the true cause of death.

Undiagnosed Case B.—G.B., a labourer, aged 35, lived in South-street (see Diagram III). He was an idler who was in the habit of doing odd jobs for R. Goff, junior, and when wanted was usually to be found hanging about the latter's store. He had been drinking from 11th January to 13th January, and thereafter had suffered rather severely from diarrhœa and vomiting. My informant first saw him on 17th January, and then noted a temperature of 102°; dyspnœa, but no physical signs in the lungs; heart's action very irregular, heart sounds feeble, pulse weak; no glandular enlargement; no albumen in urine; a boil on the buttocks. The patient died an hour or two after these notes had been made, and the cause was not assigned to plague at the time; but two or three days afterwards my informant heard of some of the circumstances now being described, and at once revised his opinion.

91. All of these persons were quite unacquainted with Cases 1 and 2, but there had been personal communication after commencement of illness between Cases 3 and 5 and Cases 6 and 8, as well as between the two households. Case 7 was unacquainted with the members of those two households, but was in the habit of visiting Goff's store to make purchases; her parents said that she had last been there "a few days" before she fell ill.

92. An interval of 19 days followed on the attack of Case 8 (20th January) during which no case of plague, nor any which caused suspicion of plague, occurred on this area, (nor, indeed, anywhere else until the seventeenth day); then the case of M.A., housewife, aged 38, was notified the day after her seizure on 7th February; morphological and cultural tests yielded positive results. She lived at 163, New South Head Road, seven doors from the produce store, though, on account of the intervening Glenmore-road, rather further than the space of seven houses away. She had no acquaintance with any of the foregoing patients. She lived in a brick house which was in average condition; but the occupants said that they had been much troubled by rats, and the disinfecting staff reported many rat-holes in the internal woodwork, as well as through the foundation walls, though no live rats nor any carcases were found. But the landlord had already been appealed to on this score, and on 7th February he had caused the ground floor boards to be taken up; quantities of rat-rubbish had been taken from the underspace, as well as two putrid carcases. It is to be noted that a carrier lived next door where he kept two horses. Three days later the following case was notified from a distant neighbourhood:—

Case 14.—J.H., house-painter, aged 59. Suddenly attacked on the morning of 10th February, after going to work, with headache, diarrhœa, abdominal pains, and fever; he exhibited a solitary, left femoral, bubo. Morphological, cultural, and inoculation tests, all yielded positive results. Recovered; duration of illness, thirty-five days.

93. J.H. lived at 192, Albion-street, Surry Hills, about a mile distant from the Paddington area, and in a district from which no cases had been reported for diagnosis. The house was one of a brick terrace; it was in good repair, and well kept; the inhabitants said it had no rats, and the disinfecting staff reported that it was entirely free from traces of infestation. No other case occurred in this household, which consisted of twelve persons. Judged in the usual way, it appeared that J.H.'s residence could not have been the place of his infection. But his occupation led him into other neighbourhoods, and into other premises; and when his movements came to be inquired into it turned out that he was the man whom M.A.'s landlord had employed to raise the floors at 163, New South Head Road, and who had removed the rubbish and the dead rats from beneath them on 7th February. This is a very important and interesting case, to which there will be occasion to refer in another connection; in the meantime it need merely be pointed out that the patient received the infection by inoculation in the left lower extremity, in which there were no visible wounds or abrasions, and that he fell ill a little less than seventy-two hours after he had begun his work at No. 163.

94. The occurrence of Cases 15 and 17 on 10th and 11th February concluded this sub-epidemic; it is not necessary to mention many details of them. J.G. (Case 16) was carter for another produce dealer, and lived quite close to Goff's (see Diagram III);

no

no dead rats were found either at his place of residence or of employment. P.B. (Case 17) was a schoolboy, who lived at a public-house at the corner of Maclean-street. His residence showed the signs of moderate infestation with rats usual on public-house premises, in certain parts of it, and no more; no dead rats were found, nor had the inhabitants seen any; but on 15th February a plague rat was collected from No. 10, Maclean-street, a cottage three or four doors from the public-house. These two patients were said to have had no communication with any of the previously infected households.

95. In order to complete this account it is necessary to review the efforts made to ascertain the state of the area as to infection of its rats. It carried only 163 premises altogether. As has been already mentioned, the rat staff had been directed, on 14th January, that is to say as soon as mortality among the rats which infested Nos. 145 to 149, New South Head Road, had become known, to search those cottages and the immediately adjacent roads, lanes, &c.; and the result had been to show that the rats referred to had suffered from sickness and had died, but had by that time gone away. But the search, which should have extended to slightly more distant streets, was not prosecuted with vigour until after occurrence of Case 17. Thus, down to 12th February only 23 rats, taken on 12 premises, had been brought in; but between that date and 17th February as many as 129 rats were collected by trapping at 60 different premises. The result of this more energetic and more systematic hunt was that on 14th February one plague rat was taken in a builder's yard across New South Head Road, immediately opposite to Goff's store; on the same date another at No. 155, New South Head Road, also a produce store, on the same side as Goff's, but separated from it by Glenmore-road and the premises at the corner opposite to Goff's; while on 15th February a third plague rat was taken, as already noted, at 10 Maclean-street. There is here sufficient evidence of dissemination of the infection of plague among the rats of the neighbourhood; nevertheless I note the infrequency of the disease among the total rats brought in to the laboratory, and reserve this point for the present.

96. The whole of the area affected was taken in hand by the cleansing staff, and thoroughly scavenged, many out-buildings having been pulled down and burnt, and some premises which were unfit for human habitation closed and demolished. The disease did not spread beyond the limits, which include about 16 acres, shown by Diagram III, partly, no doubt, in consequence of the measures taken, but in part also owing to large tracts of park or garden ground, and of vacant lands, by which it was more or less closely bounded to the north and west.

South-Central Area Resumed.

97. We must now return to the South-Central Area, and to Case 4, which was the next to occur upon it.

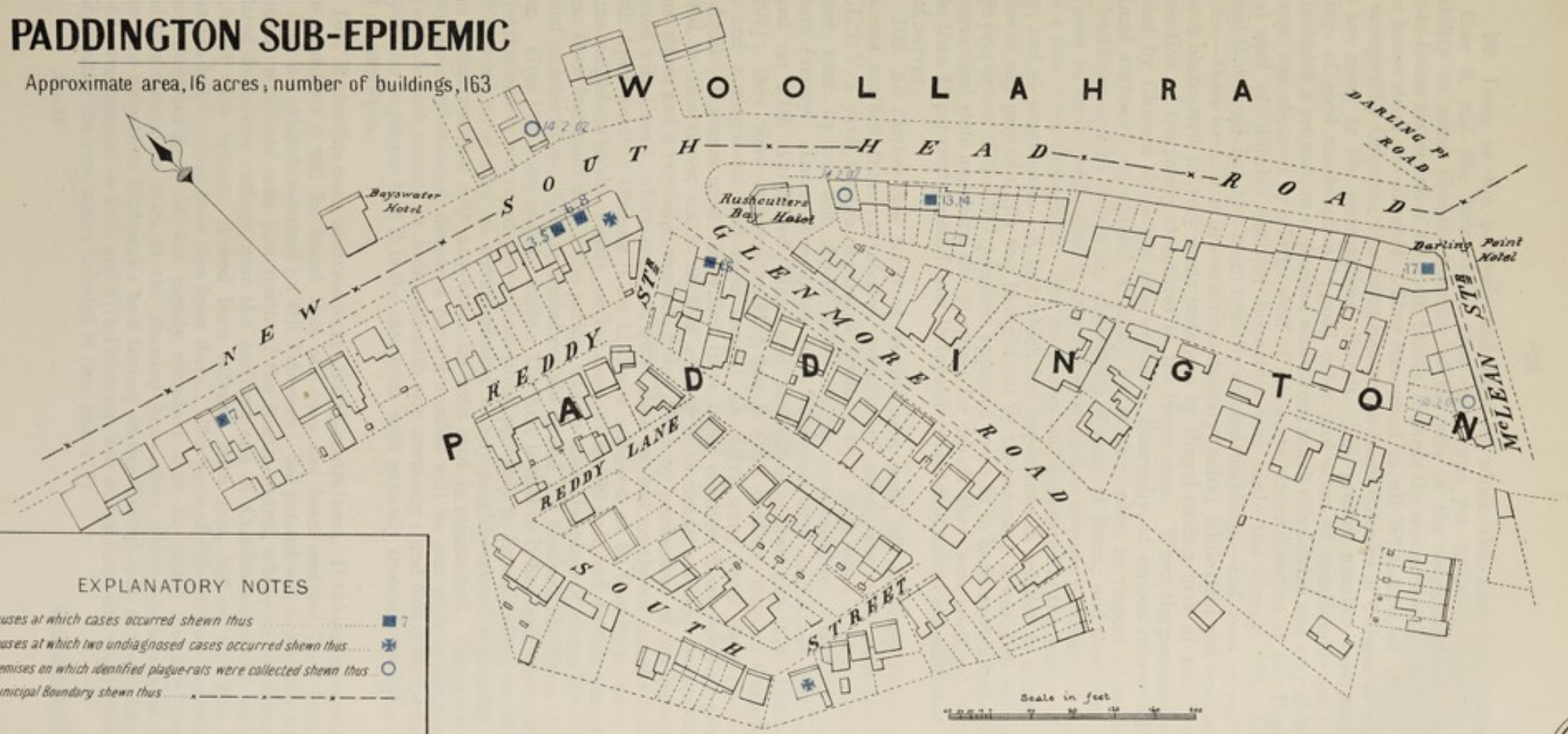
Case 4. V.U.E.V., m., aged 34, a publican, not inoculated, was suddenly attacked during the afternoon of 12th January with shivering, and at the same time discovered a small lump in his right groin, where an inguinal bubo subsequently developed. The morphological test applied to liquid abstracted from the bubo was negative; cultivation and inoculation tests yielded positive results in due course (on the third day of illness this patient's blood was, for some reason, submitted to the same three tests, all of which yielded negative results). Recovered; duration, fifty seven days.

98. The patient was unacquainted with any of the persons previously attacked. He carried on his business at the corner of Goulburn and Castlereagh streets, a point about 2 chains from the dispensary with which Case 2 was connected, and which stood in Castlereagh-street, and about 12 chains from Exton's produce store, where Case 1 had been infected two months earlier. About the beginning of December he had reported to his Local Authority that his premises were infested with rats, and said that soon afterwards he had counted 17 in his kitchen one night; later still he had found a dead rat, and about the same time there had been a very offensive smell, as though dead rats lay concealed, but no more were found. The other residents said at the time of inquiry that the house had been infested shortly before, but that they had seen no rats since the closing of a neighbouring restaurant. The disinfecting staff reported that there were no quite recent traces of infestation, and although traps were set, no rats were caught. There were seven inhabitants, among whom no further illness occurred.

Prepared for the Department of Public Health

PADDINGTON SUB-EPIDEMIC

Approximate area, 16 acres; number of buildings, 163



EXPLANATORY NOTES

- Houses at which cases occurred shewn thus ■ 7
- Houses at which two undiagnosed cases occurred shewn thus ✠
- Premises on which identified plague-rats were collected shewn thus ○
- Municipal Boundary shewn thus ——×——×——

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99. Long as the intervals had been by which this case was separated from Case 2, and the latter from Case 1, it was yet taken to point in all probability to some obscure infection of the rats in the neighbourhood, and a house-to-house inspection of six small blocks, towards the centre of which V.U.E.V'.s public house stood was directed. They comprised in all 387 houses, of which 169 were occupied by Chinese; this being one of the small colonies of Chinese of which there are many in the metropolitan district. The greater number were modern buildings of good construction, in good order, and often of considerable size; but they included a proportion of ancient structures, much dilapidated and very ill-kept. The area was cleansed by a large staff of labourers, under direction of the Departmental staff of educated sanitary inspectors who made the survey. The latter reported that in all but the more recently erected buildings—and even on some of them too—there were more or less serious sanitary faults; while light and ventilation had been obstructed in very many instances by illegal roofing over of small yards and erection of temporary structures in the larger ones. When the premises were occupied by Chinese there was also evidence, internally, of serious overcrowding. The local authority was advised to apply for closing orders in respect of many of these buildings and to secure the demolition of some of them; and there was one small area in such a state that it was recommended to acquire possession of it and to run a new street through it. But no illness was discovered in the course of the survey, and no plague-rats. A fact which has importance in relation to general rat searches in any part of a city was brought out by the records; it was, that although a large proportion of the 387 premises appeared to be fit to harbour rats both from their structural state and from the purposes for which they were used, yet only 57 (or less than 15 per cent.) were found to furnish evidence of actual infestation at the time of survey.

100. No further case occurred on this area until 9th February (Case 16), which was notified from rat-infested premises of which the back yard abutted on V.U.E.V.'s yard, though separated from it by a high brick wall. Another occurred near by on 3rd April (Case 93) in a sempstress, employed at a furniture factory. Later, three other cases were met with in Chinese, who were attacked on 27th April, 3rd May, and 15th May (Cases 112, 117, 126—see par. 207); they were infected at Hop Lee & Co.'s produce store in Campbell-street, and a plague-rat had been caught six doors away from Hop Lee's on 22nd April. It seems most likely that these cases resulted from infection newly imported to this street, which, at that end of it, is almost entirely occupied by produce stores and a vegetable market, rather than by persistence of the infection associated with Case 1, which occurred quite close by, but nearly six months before. On 30th April another Chinese (Case 113) was attacked at 59 Goulburn-street, in the same neighbourhood. Lastly, on 1st June, Case 136 occurred on this area, but not near those last-mentioned; the patient was an idler, the place of whose infection remained undetermined, it being almost certain he did not contract his illness at his lodging. Here two notes may be made: The first is that as it has been shown that the infection can be conveyed *per saltum* (most probably to Exton's store, certainly to Goff's store), so it may be communicated to any neighbourhood repeatedly, as long as communication with any other infected spot is maintained. Secondly, in any long series of cases of disease a certain number will be met with in which the source of infection cannot be indicated with any certainty; and this is so far from being peculiar to plague that it is the case even with so easily traceable an infection as that of small-pox.

101. No further cases occurred on the South-central area. If the serial numbers are now examined it will be found that one case has been omitted from notice. This is Case 9. Attack occurred on 4th February; the patient was a newsboy who lived on an undefined area just north of the North-central, where he inhabited a dilapidated four-room cottage, near the northern end of Cumberland-street, which was infested with vermin; it had been infested with rats, but at the date of examination had for long been free from them. The place of this patient's infection remained undetermined; it was merely surmised that he might possibly have received it in calling for stock at the *Evening News* office, which was separated by a narrow lane only from Siddaway's boot factory on the Central area, at which Cases 34 and 43 were infected on 24th and 27th February, and where there was considerable mortality among the rats which infested it (see par. 217).

Chippendale Area.

102. It is necessary here to describe only two of the cases which occurred on the Chippendale area, but the following Table gives a complete list of all of them :—

Table XI.—Showing the serial number, date of attack, adjudged place of infection, and residence, of the eight cases which occurred on the Chippendale area.

Serial No.	Date of attack.	Adjudged place of infection.	Residence.
	1902.		
10	February 5	Sportsman's Arms Hotel, 171 George-street West ...	The same.
12	„ 5	Fish and oyster saloon, 167 George-street West... ...	„
37	„ 20	68 O'Connor-street, Chippendale	„
62	March 16	5 Chambers-street, Ultimo	„
82	„ 21	16 Dick-street, Chippendale	„
92	„ 29	16 Dick-street, Chippendale	„
102	April 18	89A George-street West, City	„
105	„ 20	66 O'Connor-street, Chippendale	„

103. Cases 10 and 12 were attacked on 5th February at 171 and 167, George-street West. These houses were about 11 chains distant from Jones's produce store, and on the opposite side of the road (see par. 84).

Case 10. T.C., potman, aged 42 ; place of residence and of employment, Sportsman's Arms, 171, George-street West. Suddenly attacked 5th February, afternoon ; right femoral bubo ; morphological, cultural, and inoculation tests, positive. Recovered.

Case 12. G.W., a fishmonger, aged 35 ; place of residence and of employment, a fishmonger's shop, 167, George-street West. Attacked 5th February ; right femoral bubo ; morphological test, positive. Recovered.

104. The premises were next door but one to each other, and it will be noticed that both were used in a way likely to attract rats to them. At No. 171, it was said that rats were plentiful both in the neighbourhood and about the public-house itself; but not that there had been any observed mortality among them. The yard was tar-paved and undermined ; part of it was dug up and six putrid carcases were revealed. Three more were found at a gully communicating with an old drain which had not been removed when the premises were connected with new sewers ; from this rat-burrows were traced, and dug out, which ran under the intervening house, No. 169, and passed into No. 167 ; a plague-rat was taken out of them, which was identified in the laboratory on 10th February. The disinfecting staff also killed three rats which were healthy. G.W. (Case 12) was employed and resided at No. 169 ; his house was not noted to have been greatly infested.

Alexandria and Waterloo Area.

105. We now have to describe establishment of another distant, and apparently independent, centre in connection with a fourth produce store (see Diagram IV).

Table XII.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the eighteen cases which occurred on the Alexandria area.

Serial number.	Date of attack.	Adjudged place of infection.	Residence.
11	February 6	8, Henderson-road	Belmont-street.
35	„ 22	30, Botany-road...	The same.
36	„ 25	68, Botany-road...	„
45	March 1	30, Botany-road...	„
73	„ 19	90, Wyndham-street	„
*79	„ 22	14, John-street	„
90	„ 31	20, John-street	„
98	April 13	1, Bourke-street...	„
107	„ 23	60, Phillip-street	„
109	„ 26	31, Raglan-street	„
115	May 4	Retreat-street, Botany-road ...	„
125	„ 11	Gray's Stables, Waterloo ...	151, Bullanaming-street.
133	„ 28	Grimley's Tannery, Botany-road	105, George-street, Redfern.
132	„ 29	69, Beaumont-street	The same
135	June 5	30, McEvoy-street	„
137	„ 2	77, Cooper-street	„
138	„ 5	17, Botany-street	„
139	„ 8	Louden's boot-factory, Elizabeth-street	54, Morehead-street.

* In Diagram IV this erroneously appears as No. 74.

Case 11. A.H., produce dealer, aged 30; place of residence, Belmont-street, Alexandria; of employment, 8 Henderson-road, Alexandria. Suddenly attacked 7th February, at 7 a.m., with vomiting, headache, and fever; right femoral bubo; both extremities much flea-bitten. Died 12th February.

106. A.H.'s cottage, in Belmont-street, was of weatherboard, in good repair, and clean; it had a stable for three horses in the backyard; the skeletons of three rats were found at the bottom of a dung-heap, but there was no evidence of infestation. The produce store stood close to the Botany-road, at a distance from the cottage of 56 chains. It was also 40 chains from R.B.'s residence (Case 1), where that patient had lain ill for the four or five days from 4th to 8th November. It was a wood and iron building, which measured 19 feet by 47 feet; it had a brick front, and was floored with wood. There was a stable in one corner, and the place was dirty and ill-kept. For several weeks before his attack A.H. had not slept at home, but at this store on an extemporised bed of sacks. On taking up the floor the carcases of 39 rats were turned out, all too putrid for laboratory examination, and three healthy rats were killed.

107. Here this account of the beginnings of the epidemic may usefully be interrupted in order to point out that evidence of the dissemination of plague-rats in connection with no less than four produce stores has been adduced, namely, Exton's, Jones's, Goff's, and Huxley's; that bales of hay, &c., are notoriously liable to infestation by rats, which are easily transported in them; and that all four places were almost certainly connected, by the nature of the business carried on at them, with that line of wharfs at which produce is habitually handled, and at one of which a plague-rat was taken almost as soon as the rat search began, namely, on 18th November. We have seen, also, that plague in man occurred in connection with three out of these four stores; and, in the three widely separated neighbourhoods in which they stood, it first occurred in persons connected with the stores either as workmen, or as occupants of adjoining houses in free communication with the store by the space under the joists. Lastly, that the rats were affected before man; this was not demonstrable in Case 1, since the date of notification enabled search to be made only 10 days after attack; but, on the other hand the patient certainly did not infect the rats for reasons already mentioned (par. 77). The evidence on this head relating to Case 3, Paddington area, seems quite clear. Again, it is quite clear in relation to Case 11, for although the search was instituted within 48 hours of the time of attack, all the carcases found were not merely putrid, but too putrid for any useful examination in the laboratory. Later, other instances will be given in which there was no doubt at all that sickness and death of the rats had preceded the first case of illness among the persons inhabiting the premises where the carcases were found; such, for instance, are Group C, Cases 24 and 30, Her Majesty's Theatre and Hotel, and the Criterion Theatre and Hotel (pars. 198, 199, 210 to 216). If Case 1 be excepted, as I do not think it need be, then it can be said that disease in rats preceded disease in man in every case, the evident want of continuity between cases, and the observed establishment of independent centres, being borne in mind. For this discriminative infection of distant spots permits each such occurrence to be considered by itself, and to be regarded as complete in itself. Here, also, the reader will note the absence of infection in man in connection with Jones's store and the house in Cleveland-street; and while this point will be further examined below, the opportunity may be taken of repeating the remark already made (Report 1900, p. 36), that some special condition not usually present seems requisite to secure communication of the infection from rat to man.

108. The large block in which Huxley's store (Case 11) stood was taken in hand by the cleansing staff, but operations within it were not finished for about a month. No plague-rats were discovered in the course of them, nor any other instance of rat mortality. It was not until 21st March, more than a month later, that a plague-rat was collected in that block from the stable of a cabman 6 chains distant from Huxley's store, two days after his son had been attacked with plague (Case 73, the fifth on this area). Other plague-rats were taken later in the neighbourhood: one was identified among many carcases removed from 47, Henderson-road, which was a butcher's shop (see par. 111), and one at each of the houses 14 and 16, Botany-road, on April 8th and 9th, of which one was also used as a butcher's. No case of plague occurred at any of these houses.

109. The second case on this area happened sixteen days after the first in a school-boy (Case 35, attacked February 22nd, removed February 26th; right femoral bubo, recovered) at 30, Botany-road. This house stood north of, and 8 doors from, Henderson-road, and well within a hundred yards of Huxley's store. It was occupied by a pawnbroker, and was in a poor state of repair and maintenance. Floors were lifted, and a great deal of rat-rubbish removed from beneath them; there were holes in them and in skirting-boards, &c., as well as some burrows in the back-yard; no carcases were found and no live rats were seen. But the burrows were not dug out. This was an omission, of which the full significance was not perceived until after the experience gained at the Zoological Garden (see par. 176). It is here pointed out in connection with the occurrence of another case on these premises a week later, and after they had been cleansed and disinfected (Case 45, the fourth on this area, the above-mentioned patient's father, attacked 1st March).

110. The third case (Case 36) happened at 68, Botany-road, the patient, a child, having been attacked 25th February, on which day, also, he died (spleen and bubo yielded *b. pestis* in smears); this house having been on the same side of Botany-road as the last-mentioned, and only 12 doors south of it, though also separated from it by the intervening Henderson-road. It was therefore within a few yards of A.H.'s store. These premises were in very bad repair, and filthy; they were occupied by the patient's father, who was a dealer in bottles and old iron; 10 carcases of rats at about the same stage of putrefaction were removed, together with no less than 36 loads of rubbish and filth, but no plague-rat was identified.

111. The fourth and fifth cases (Cases 45 and 73) have been already mentioned; the sixth (Case 107) happened much later. It occurred in a letter carrier who was attacked on 23rd April. He lived at 60, Phillip-street, in a house which had a stable attached to it. The former was in good order and repair, and the inhabitants said they had no rats; nevertheless on lifting the floor 3 carcases were removed, all of which were too putrid for laboratory examination. This house stood about 15 chains from A.H.'s store. But it was only 6 chains from the shop of one Kerrigan, a butcher, on whose premises a sick rat, which was shown in the laboratory to be suffering from plague, had been taken on March 26th; on cleansing the shop immediately afterwards 80 putrid carcases were removed from the space under its rotten ground floors.

112. Two further cases (Case 115, 4th May, and Case 133, 28th May, being the eleventh and thirteenth on this area) occurred on this, the western side of Botany-road; they were separated from those above-mentioned, not so much in time as by distance. The premises on which they were judged to have been attacked stood 36 chains to the south of Henderson-road (A.H.'s store, &c.), and it is possible that the infection reached them from the eastern side of the road; for further cases had occurred in the immediate neighbourhood of Raglan-street on that side, and had gradually extended in a southerly direction until they had reached land opposite to that on which the houses of Cases 115 and 133 were placed. The series referred to comprised 11 cases (which occurred between Case 79, 22nd March, and Case 138, 8th June). The first two of them occurred in John-street, about 18 chains south-west from Raglan-street; the third, 18 chains further away towards the south; the remainder at various points between those two, and more or less removed from the east side of Botany-road. Case 79, a little girl, of John-street, was attacked (right inguinal bubo) on the third day after she had picked up and thrown out of her garden a dead rat; and on lifting the ground floors of her cottage, four carcases were found. Then Case 98, attacked 13th April at the southernmost extremity of the area, lived eight doors from the Zetland Hotel in Bourke-street, and from stables attached to this hotel a plague-rat was taken on 21st April. So also Case 125 occurred in a man who was attacked 11th May, at his place of employment, Gray's stables, within a short distance of the Zetland Hotel; and on 26th April a plague-rat had been caught at these stables. Sufficient evidence of a dissemination of plague-rats over this infected area was forthcoming, although household connection between diseased rats and the persons attacked was not established in the remainder of this short series.

Prepared for the Department of Public Health

ALEXANDRIA-WATERLOO AREA

Scale of Chains

NOTES

THIS DIAGRAM *shows by blue spots the places at which the 18 cases which constituted this sub-epidemic are adjudged to have received their infection. It shows, also, the places at which identified plague-rats were collected by blue open circles, but not the number of such rats. Blue circles which enclose a cross indicate houses at which persons adjudged to have been infected elsewhere resided, and at which they lay during the earlier days of illness. The numbers are the serial numbers of the cases referred to (for detail see Appendix A.)*

TABLE XIII.—Showing the situation of premises on the Alexandria area at which plague-rats were taken, and the dates on which they were taken.

90, Wyndham-street	March 21.
47, Henderson's-road (Kerrigan's)	March 25.
16, Botany-road	April 8.
14, Botany-road	April 9.
Bourke-street (Zetland)	April 21.
Gray's stables, Elizabeth-street	April 26.

113. Lastly, on 8th June, which, as it afterwards turned out, was the day on which the last case of this epidemic was attacked, and on this part of the area, the latter was ordered to be specially searched by the rat-staff. During four or five weeks a large number of rats were gathered from 84 premises very evenly distributed over it (see diagram IV; the part referred to is bounded on two sides by Botany-road and Phillip-street, and on the third, in part, by Bourke-street). None were infected with plague.

SURVEY OF THE GENERAL RESULTS OF THE SEARCH FOR RATS OVER THE WHOLE OF THE AFFECTED AREA DOWN TO 17TH FEBRUARY.

114. In order to complete this description of the beginnings of the epidemic, it is necessary to add a reference to the general rat-search which was simultaneously carried on over a very considerable section of the city. I take, for the illustrative purpose in view, that part of it which lay between the dates, 16th November and 17th February (Case 23).

During the three months, 16th November to 17th February, rats were brought in by three agencies—the Departmental rat-staff, which delivered a few more than 12,000; the staff of the Local Authority for the city, which brought in 1,732; and those collected by the public and paid for by the Department at 3d. a head, which numbered nearly 18,000. The Departmental staff worked over a very wide area, including the city and adjacent suburbs, as well as some rather more remote which were occasionally visited, and those from which plague-cases had been removed; the city staff confined itself within its municipal boundaries, of course; while the origin of those presented by the public was seldom accurately known, though steps were taken to prevent them from being imported from distant places The Departmental staff visited and attempted to catch rats at a very large number of premises altogether, although even this total number bore but a small proportion to the total houses standing in the adjoining and other municipalities within which they worked; but the premises to which they paid *successful* visits numbered but 438 houses, &c., and 48 wharves; and their *successful* visits to this small number of premises were but 1,581. The only plague-rats which were identified were handed in by the Departmental staff; and as a rule the addresses at which rats brought in had been caught were known with certainty only when they had been taken by that staff. The net result of this hunt as regards plague rats is given below:—

TABLE XIV.—Showing the places at which identified plague-rats were collected between 16th November and 17th February, the dates on which they were collected, and the area on which these premises stood (see Diagram II).

Exton's produce store, Hay-street	November 15	South-central.
Howard Smith & Co.'s, Brisbane Wharf... ...	November 18	Darling Harbour.
Jones' produce store, 84, George-street	November 25	Chippendale.
Cleveland and Abercrombie Streets	November 26	Chippendale.
400, Kent-street, City	January 28	Darling Harbour.
Her Majesty's Hotel, 186, Pitt-street..... ...	January 29	Central.
445, Kent-street	February 6	Darling Harbour.
392, Kent-street	February 8	Darling Harbour.
169, George street West	February 10	Chippendale.
180, Pitt street	February 14	Central.
Buchanan's, New South Head Road	February 14	Paddington.
Matheson's produce store, New South Head Road	February 14	Paddington.
10, Maclean street, New South Head Road ...	February 14	Paddington.

But these plague-rats must not be regarded as the total yielded by the 12,000 rats taken by the Departmental staff; they should be compared with the number selected for delivery at the laboratory under conditions which have been already mentioned (see par. 81); and that was 914.

115. Thus the number of places at which plague-rats were found during the three months, 16th November to 17th February, was but 13, and the number of plague-rats identified was but 18. There were, however, a large number of rats which died of plague, their carcases having been found on premises which yielded at least one identified plague-rat; and were these reckoned the proportion of plague-rats to rats caught would be very largely increased. But this would add nothing to our knowledge; for we are aware that plague often rages on premises which are grossly infested, and consequently that the number of plague-rats found must

must largely depend on the numbers which happen to lodge on the premises invaded. The more important point is to ascertain the number of separate premises and the number of different neighbourhoods in which plague-rats were found; this it is which indicates the extent to which the disease is disseminated as an epizoötic, and which, in my opinion should be compared with occurrences of it in man. That number was 13 premises only. It should surely have been larger; for some infected rats were found at several widely separated spots, and from experience at several premises (Exton's, Jones's, Huxley's) it is plain that the disease is sometimes easily communicated from rat to rat. The failure to discover more must have lain in part, then, in the mode of search; and good reason can be shown for ascribing it to this cause. The rat-staff worked at night, and with traps. They therefore caught rats which were running about and which were, for the most part at all events, in good health. Experience at Sydney has been that rats which have been attacked with plague have rarely been seen in the open; one instance has been mentioned in connection with the Paddington area, another will be mentioned in connection with a flour-mill on Darling Harbour area, another at the Zoological Garden (par. 174); but only four altogether were noted. Had they more frequently behaved, however, as they have been said to do in other countries, it is still improbable that they would have been taken in traps; for it is not likely that a sick rat would have either the energy or the inclinations which would lead it into them.

116. It seems sufficiently clear that the epizoötic did not spread very rapidly from building to building; doubtless it was often impeded by the mode of construction, which was that usual in European cities. Further, the disease seems to have been very easily communicable from rat to rat only under the special circumstance of association of large numbers in confined quarters. Nevertheless, there must have been many more infected rats than were found. Where were they, then? They must have been underground in their burrows; to them they must have retired on falling ill, and there for the most part they must have died. Some direct evidence that this does happen was yielded by the case of the Zoological Garden (par. 176); and, indeed, it was not until after that experience that the great importance to the epidemiological study of searching for and digging out burrows in connection with buildings was perceived.

117. But there was still another reason why plague-rats were not found in greater numbers; it arose from the search-conditions. In the first place, although it is impossible to estimate the number of houses on the irregular area which was the field of the operations under review with any approach to accuracy, it is quite certain that the premises at which rats were taken during the three months formed but a very small proportion of them. In the second place, it was indispensable that some number of rats should be fixed upon as sufficient evidence that each rat-catcher employed had done a satisfactory amount of work, and an effect of this practically unavoidable rule was, no doubt, to lead to payment of repeated visits to premises which were badly infested, while what was more desirable was examination of the largest possible number of different premises.

118. I conclude, then, first, that the identification of plague-rats as carried out furnished a trustworthy indication of the area of country over which the epizoötic extended, and that there is no good reason for supposing that it may have reached much beyond it; secondly, that it furnished little indication of its intensity.

119. There are two additional points upon which some remark should be made for the reader's assistance. The first is that there must, of course, have been some local *fons et origo* of the infection; and it is apparent that the latter spread from it, not by continuity at first, but *per saltum*, primary cases having been recognised in four separate districts, namely:—Cases 1 on the South-central, 10 and 12 on the adjacent Chippendale, 3 on the Paddington, and 11 on the Alexandria area. This view (of spread, at first *per saltum*, but afterwards by continuity from each new centre) depends on the cases mentioned having been primary cases in fact. Now notification of Case 1 was delayed until ten days after the date of attack; and two undiagnosed cases occurred on the Paddington area, where also Case 3 lay without medical attendance for nine or ten days after attack. These facts raise a legitimate doubt whether apparently primary cases were so in truth. Against

it

it may be pointed out (*a*) the absence of all ground for suspecting wilful concealment—a statement which applies as much to the Chinese, who here live as civilised and law-abiding citizens, as to whites; (*b*) that attention was drawn to one of the two undiagnosed cases by the medical man who had been in attendance upon it (to the extent, it will be remembered, of one visit paid an hour or two before death) as soon as he heard of the surrounding circumstances, while the diagnosis of the other (made after death without assistance of a detailed *post-mortem* examination) may, after all, possibly have been correct; (*c*) that all those who are best acquainted with the general circumstances do accept these early cases as having been the primary occurrences they appeared to be. Such investigations as the present would become impossible were this doubt (which, in a measure, might be raised in relation to the source of infection of every case) entertained without very good evidence for it; and evidence of the requisite kind may, in my opinion, be taken to be wanting.

120. The second point is, the detection of plague-rats (to speak generally) on premises where there was no plague in man, and the failure to find them (in a majority of cases) where there was plague in man. Enough has already been said, I think, to show that the negative aspect of these facts must be cautiously regarded. Coincidence of plague in man and in rats was demonstrated in several instances; and the failure to find plague-rats is, for substantial reasons which have been mentioned above, not even presumptive proof that plague-rats were not present. Besides this, however, it must be pointed out once more that plague-rats by themselves, and unaided, are incapable of causing epidemic bubonic plague. All that is required at this stage of the enquiry, therefore, is to show that the connection between rats and man, or the connection reasonably presumed in cases where the demonstration failed, existed as a mere matter of propinquity sufficiently often to warrant the inference that it is an essential condition of the occurrence of plague in man. This, I think, has been done even already; but much more evidence to the same purpose will be given later. However, the reader has the facts before him, and will judge of this for himself.

Darling Harbour Area.

121. The slow and obscure beginnings of the epidemic on a close-built city area, and its complete course within two other areas which comprised much more open space around the houses and much more unbuilt land in their neighbourhood, having been described, it is now necessary to give examples of its complete course, and of its relationship to epizoötic plague on areas which were altogether covered with houses, factories, markets, and wharfs. For this purpose I choose the Darling Harbour area and the Central area.

122. The number of cases which occurred upon the Darling Harbour area (see Diagram II) was 10, and they happened between 14th February and 20th April. It can be noted at once that, densely populated during the day as this area was, it did not yield cases of plague in proportionate number, although the infection was proved to have been present upon it from (I think it may be said) before the beginning of the epidemic until a date subsequent to attack of the last case by a few days, but subsequent to that of the last case on this area by nearly two months. This remark applies equally to the Central area, which yielded 32 cases between 14th February and 4th May. Yet the rise in the weekly number of notified cases which occurred, as has been shown, between the seventh and twelfth weeks (see Table II) was due entirely to addition of the 42 cases which arose on these two areas, without which the weekly number referred to would have varied between 1 and 8 only throughout the epidemic. This way of regarding the cases on the Darling Harbour and on the Central areas requires some explanation. It is justified by the fact that while the total 42 cases occurred on 29 premises, the patients resided on those premises only in 12 instances; and in the remaining 30 instances lived in districts which were for the most part remote, and, with three or four exceptions, free even from suspicion of infection with plague.

123. The 10 cases grouped on the Darling Harbour area can be further divided by locality into three sub-groups. These are shown in the Table below :—

TABLE XV.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the ten cases of plague which occurred on Darling Harbour area.

Case No.	Date of Attack.	Adjudged Place of Infection.	Residence.
		A.	
23	February 14	232 Sussex-street (flour-mill)	Hugo-street, Redfern.
25	„ 18	39 Sussex-street	Lindfield.
28	„ 22	224–6 Sussex-street (produce)	Victoria-street, North Sydney.
42	„ 27	49–51 Sussex-street (produce-carter)	Young-street, Redfern.
56	March 10	125 Sussex-street (produce)	Trafalgar-street, Annandale.
72	„ 17	Barque " Eulomene " ; potatoes supplied from 61–3 Sussex-street.	
		B.	
59	March 4	Barker-lane	7 Barker-lane.
89	„ 22	Miller's Wharf, Liverpool and Bathurst streets	Victoria-street.
106	April 20	Jones' Wharf (wood, coal), 2 Bathurst-street	2 Bathurst-street.
		C.	
104	April 20	Grafton Bond	74 Princes-street.

124. First of all, it must be pointed out that Cases 23, 25, 28, 42, 56, 89, and 104 resided in neighbourhoods which never yielded indigenous cases. Their home premises also were either not infested with rats or, if in two or three instances visited by rats, were so in quite a moderate degree ; and no evidence of rat mortality on or in the neighbourhood of them was revealed by the inquiries which were made. Cases 59 and 106 were judged to have been infected where they lived. Case 72 was infected on board his ship, which had the communication with Sussex-street already described elsewhere (see par. 71).

125. What were the rat relations of the premises on which these cases are adjudged to have received their infection ? They are shown in the Table below. It should be noted that street numbers almost always run odd and even on opposite sides of the way :—

TABLE XVI.—Showing the situation of 21 premises on the Darling Harbour area at which plague-rats were taken, and the dates on which they were taken.

Howard Smith & Co.'s Brisbane Wharf	18 November.
400 Kent-street	28 January.
445 Kent-street	6 February.
392 Kent-street	8 February.
41 Sussex-street	18 and 19 February.
31 Sussex-street	21 February.
392 Kent-street	21 February.
North Coast Co.'s Wharf	25 February.
Napoleon-street (off 6, Sussex-street and Grafton Wharf)	25 February.
Huddart, Parker, & Co.'s Wharf (about 1 Sussex-street)	28 February.
Steam Mill street (off Barker-street)	19 March.
Barker-street	18 March.
Market Wharf (near 171 Sussex-street)	14 April.
Byrnes' Wharf (foot of Liverpool-street, 345 Sussex-street)	18 April.
Federal Wharf (bond, 1st floor, 209 Sussex-street)	19 April.
S.M.C. Wharf (off 279 Sussex-street)	23 April.
89 Liverpool-street	28 April.
311 Sussex-street	1 May.
318 Sussex-street	5 May.
Duncan-street (off 31 Bathurst-street)	9 May.
Market Wharf (near 171 Sussex-street)	13 June.

126. Thus the first plague-rat of all was found at a wharf which stood more or less at the centre of the line of wharves which bounds the Darling Harbour area to the east on 18th November ; the next 3 in Kent-street towards its south end, one

one block east of Sussex-street, from 26th January to 8th February; and then follows a long list of 17, taken on premises which, with two exceptions, were either actually in Sussex-street or in side streets within a few doors of it, between 18th February and 13th June (see Diagram II). Now if Table XV be compared, it will be found that the takings of plague-rats on any premises coincided in no case with occurrence of plague on those premises; and, conversely, that plague did not occur, and that cases of plague could not, in any instance, be ascribed to infection received on premises where plague-rats were taken. It may be pointed out at once that this has been our usual experience. The total number of inhabited premises, or, more exactly, of premises which harboured people during the day, but were not used as dwellings by all of them, on which plague-rats were taken, was 40 during the whole epidemic, while plague occurred on 4 of them only. But this nett statement is not all that can be said on this point. Rats which had died from some unusual cause were often found on premises where plague in man occurred. Thus, Case 23 (both sets of cervical glands enlarged, smears and cultures positive; died), occurred in a youth employed at a steam flour-mill, who said that, on the day of attack, he had killed a sick rat at the mill by stamping on it, and had afterwards picked it up and thrown it away. The date of his infection, in all probability, was earlier than that referred to, which was the day of attack; but it appears that there were sick rats, or at least the one he killed, on the premises at which he worked. Case 25 has considerable interest from the circumstances surrounding it, although it is only one of a considerable number of similar cases. The important points were as follows:—

J.B.B., m., aged 19, a railway porter employed at Lindfield station, 7 miles from Milson's Point terminus, North Sydney. He was attacked, 18th February, in the evening; he had a right femoral bubo (morphological and cultural tests, positive); recovered. He lived in the neighbourhood of Lindfield station with his father, who had stables at his detached cottage and kept horses there; on 8th February the latter had received feed from 37, Sussex-street; the cottage was in good order and repair, clean; it was said that there were some rats about it and the stables, but that none sick or dead had been found. The patient did not work for his father, though no doubt he was exposed to any risk which may have attached to the stables; but on 18th February (railway books) he had helped a consignee to unload a considerable quantity of produce from railway trucks which had been forwarded from a store at Nos. 49–51, Sussex-street. In addition to this connection of his case with these premises, he was friendly with the son of the produce dealer who occupied them; and on 16th February had gone to Sydney and had spent the morning with him. It is not clear whether or not they entered Nos. 49–51, but No. 39 was at that time vacant. It was learned that young men used to meet there, and there the patient and his friend spent an hour or two. No plague-rats were found at No. 39 (which was not visited at any time), but they were found at No. 41, next door, on 18th and 19th February.

127. Under these circumstances, it is clearly possible that this patient may have been exposed to some risk of infection from the produce bought by his father at 37 Sussex-street, and received at Lindfield on 8th February, but this remains a possibility only; he could not have received the infection from the produce he unloaded, because he was attacked on the same day. But his visit to No. 39, Sussex-street (possibly, also, to Nos. 49-51), coincided with the most probable date of his infection; for, from the morning of 16th February (say, at 11 a.m.), to the evening of 18th February (say, at 8 p.m.) is fifty-seven hours, so that his illness began during the third day after his visit. No plague-rats were found at No. 39 (they were not searched for there) but some were taken at No. 41 (next door) on 18th and 19th February.

128. Case 28 occurred in a carter at a produce store, who sometimes slept on the ground-floor premises connected with stables in the back yard; and here, when the rotten flooring-boards were removed, a mass of rat-burrows was exposed, and 6 carcases, at about the same stage of putrefaction, were removed. Case 42 occurred in a carter at Nos. 49-51, Sussex-street, just mentioned above; but there was no history of dead rats in connection with Case 56, though the patient was certainly not infected at his residence in a distant suburb, and was carter to another Sussex-street produce dealer. The premises at which Case 59 lived, though in a neighbourhood consisting of poor house property (in very bad repair), factories, and wharfs, where plague-rats had been before and were afterwards found—one of them in the lane outside his house, and close to it—offered no sign of infestation. Stables at the wharf at which Case 89 was watchman were in bad repair and order, and infested with rats, but it was said that none dead had been seen there for three months before. Case 106 was stableman at premises attached to Jones' Wharf, and slept in a species of hutch extemporised for him. It was said that no rats had been seen, alive or dead, for a long time; however, on examination, abundant

abundant signs of present infestation were seen, and three days after this patient's attack a plague-rat was taken at the Municipal Wharf at the foot of Bathurst-street, adjoining Jones' Wharf. These premises were also infested very badly with fleas.

129. The foregoing facts afford a further and fair example of the kind of relationship between diseased rats and plague in man which we have observed on closely-inhabited and (during the day) thickly-populated business areas. The long space of time, covering duration of the epidemic, during which plague-rats were forthcoming from the area described may be noted; the small proportion of the total buildings upon it (which, together with 41 wharf premises, were 1,234) from which plague-rats were collected; the small proportion of the total number of houses in which any rats were captured (namely, 88, to which 1,170 successful visits were paid by the ratcatchers); the want of coincidence between identified plague-rats and cases of plague in man on the same premises, but also the frequent association of rats recently dead from some epizoötic disease with plague in man may be pointed out. But, on the whole, I infer that the place-connection between epizoötic and epidemic plague is far from being in reality as obscure and doubtful as from the ascertained facts, which have been given above with scrupulous precautions against exaggeration, it might be judged to be by those who have never attempted to examine the rats of a large city. For the obscurity, in my opinion, arises solely from the difficulties which the investigation necessarily presents, namely, the physical circumstances of the area to be examined and the habits of the animals, together with ineptness of the labour which alone has been available for use as an instrument of search.

Central Area.

130. We now turn to the Central area which, it seems most probable, was infected from the wharf line on Darling Harbour area, by way of streets running towards it in an easterly direction (King-street, for instance); the separation between the two areas being strongly marked by the entire freedom of Clarence-street, which runs north and south parallel with the wharf line, but some hundred yards easterly of it, both from plague-rats and from premises yielding dead rats. And it should be pointed out in relation to this latter statement (though the same is to be understood of all similar statements unless the contrary is mentioned) that the not finding of plague-rats or of dead rats in this street was not at all due to less thorough or briefer search in the houses which composed it.

131. The number of cases which occurred on the Central area was 32, and they can be divided by locality into 4 sub-groups; they are shown in the Table below.

Table XVII.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the 32 cases of plague associated with the Central area.

Serial Number.	Date of Attack.	Adjudged Place of Attack.	Residence.
A—			
18	Feb. 14 ...	Her Majesty's Theatre, 186 Pitt-street...	130 Reservoir-street.
19	Feb. 14 ...	Do do ...	22 Bullanaming-street, Redfern.
20	Feb. 15 ...	Do do ...	247 Church-street, Camperdown.
21	Feb. 12 ...	Do do ...	115 Nelson-street, Leichhardt.
33	Feb. 25 ...	Her Majesty's Hotel, do ...	Her Majesty's Hotel, 186–8 Pitt-st.
22	Feb. 16 ...	George Hotel, 188 Pitt street	George Hotel, 188 Pitt-street.
34	Feb. 24 ...	Siddaway's, 47 Market-street	59 High Holborn street.
43	Feb. 27 ...	Do do	Bondi.
B—			
26	Feb. 19 ...	Criterion Hotel, 258–262 Pitt street ...	George-street, Redfern.
27	Feb. 22 ...	Do do ...	Paragon Hotel, Circular Quay.
29	Feb. 21 ...	Do do ...	Criterion Hotel, 258–262 Pitt-street.
31	Feb. 23 ...	Do do ...	do do
32	Feb. 22 ...	Do do ...	do do
39	Feb. 24 ...	Do do ...	do do
40	Feb. 25 ...	Do do ...	do do

Serial Number.	Date of Attack.	Adjudged Place of Attack.	Residence.
C—			
41	Feb. 27 ...	482 George-street (chambers)	Orwell-street, Pott's Point.
51	March 3 ...	(?) 251–7 Pitt-street	198 Oxford-street.
46	March 3 ...	(?) G.P.O., 137–57 Pitt-street	Hurstville.
49	Feb. 28 ...	237 Pitt-street	Petersham.
55	March 12 ...	155 King-street...	164 Woolloomooloo-street.
57	March 10 ...	Imperial Arcade (off 170 Pitt-street) ...	165 Liverpool-street.
76	March 16 ...	105 King-street...	Bannister-lane, Ultimo.
80	March 25 ...	134 King-street...	134 King-street.
81	March 25 ...	Strand Arcade (off 195 Pitt-street) ...	Randwick.
84	March 26 ...	Royal Arcade, 267 Pitt-street	Strathfield.
116	May 4 ...	(?) 305 Pitt-street	37 Hutchinson-street, Surry Hills.
D—			
52	March 11 ...	Central Exchange Coffee Palace ...	Central Exchange Coffee Palace.
53	March 11 ...	Do	do
60	March 13 ...	(?) Do	115 Erskineville-road.
67	March 18 ...	111 York-street...	70 Walker-street, Redfern.
69	March 13 ...	(?) Central Exchange Coffee Palace ...	554 Crown-street.
75	March 20 ...	35 Market-street	8 Healey-street.

132. The 32 cases which occurred on the Central area were infected, as far as can be judged, on 17 premises only. A note of interrogation preceding the adjudged place of infection intimates that doubt attaches to it in that relation. At Her Majesty's Theatre and Hotel (which constituted one building structurally) 5 cases occurred, 2 at Siddaway's boot factory, 47 Market-street, 7 at the Criterion Hotel (and Theatre), 2 (probably) at chambers which ran through from 251–7 Pitt-street to 482 George-street; and in the Group D, which lay west of George-street, 4 (probably) in connection with the Central Exchange Coffee Palace. Their dates of infection extended only between 14th February and 26th March, if Case 116 (attacked 4th May) be omitted which may perhaps be done, because there was almost equally strong reason against regarding either the patient's place of residence or his place of employment as the place of his infection.

133. The ascertained state of the Central area as regards epizoötic plague is shown in the table below:—

Table XVIII.—Showing the situation of premises on the Central area at which plague-rats were taken, and the dates on which they were taken.

Her Majesty's Hotel and Theatre, 186–8 Pitt-street ...	Jan. 29, 30, 31, Feb. 1, 8, and 11.
180 Pitt-street	Feb. 14.
484A George-street...	Feb. 22.
Imperial Arcade, next 170 Pitt-street	Feb. 25.
74–78 King-street	Feb. 25.
King-street (F.F.I. Co.'s "new shop")	Feb. 26.
St. Andrew's School, 314 Pitt-street	March 4.
92 King-street	April 4, 5.
218 Pitt-street	April 5, 11.

134. On this area, then, plague-rats were identified in connection with Her Majesty's Theatre and Hotel (but see the special account of these and other premises which yielded multiple cases, pp. 52–56); dead rats in number at the Criterion Hotel; the same at 47 Market-street; a plague-rat at 484A George-street on 22nd February, which building is next to 482, where on 27th February Case 41 was attacked, and which also ran through to 251–7 Pitt-street, where Case 51 (attacked March 3) was at work as a house painter. Case 49 worked at a very badly infested tailor's shop, though no carcases were found at it. Case 55 worked at an hotel, where plenty of rats had been seen, and where (as the patient said) a sick rat had been caught the day before his attack, though no carcases were found. It was ascertained at the restaurant at which Case 57 worked, that 3 dead rats had been taken from under a staircase a few days before her attack, and it will be observed that No. 170 Pitt-street (see Table XVII) is but five doors from No. 180, where a plague-rat was taken on 14th February. Case 76 worked at a mercer's, which was badly infested, and whence 4 putrid carcases had been removed three days before her attack,

and

and 4 rat-nests from under the flooring-boards. Case 80 lived at a publichouse very badly infested, both by vermin and rats, whence 4 carcases and large quantities of rubbish accumulated by rats were removed. Case 84 occurred at a tailor's, where 9 carcases were removed from under the floor of the room in which the patient had worked, as well as very large quantities of accumulated rat-rubbish. So, also, as regards Sub-group D, very many carcases, live rats, rats' nests, and large accumulations of rat-rubbish were removed from the place at which Cases 52 and 53 lived and were attacked (compare, also, Cases 60 and 69, who more or less regularly frequented this eating-place). But, as regards the rest of this sub-group, no good evidence of disease among the rats which, nevertheless, infested the places of their employment, was obtained. Next, as regards the dwellings of those who did not reside at the adjudged place of their infection (namely, 22), seven lived in very remote suburbs, at distances of from 3 miles to 9 or 10 miles, only one of which ever yielded an indigenous case (but see Cases 61 and 127, Camperdown area, for the special circumstances), or harboured an imported case. The remainder lived at less distances of a mile or two, and not in suburbs; a majority of them dwelt in neighbourhoods which never fell under suspicion of infection. There were but two or three among them who could be considered to have run some danger from locality, but in no case were the dwellings of any of them found to have harboured dead rats, or to be infested with rats; nearly all of them having been absolutely free from all traces, I will not say of infestation, but even of visitation. Enough has been said, perhaps, of the Central area to show once more the kind of relationship which has been observed between plague-rats, or dead rats, and plague in man; and to show why, in the absence of evidence of spread by all those means which are elsewhere constantly invoked to explain the epidemicity of plague, we have concluded that, at Sydney, epizoötic plague is causally connected with epidemic plague, and not merely with occasional individual cases of this disease.

General Survey of the Remaining Areas.

135. The North-central area afforded but 6 cases of plague, of which 5 occurred at one house. Further reference to it may, therefore, be delayed until premises which yielded multiple cases come to be separately examined; but in the meantime it should be noted that in all respects of occupation and population, it was similar to the Central area just dealt with. Two of the 5 areas which alone remain to be noticed yielded 6 cases each on 5 premises in each, while the other 3 yielded only 2 cases each on 2 premises in each. These 5 areas are Woolloomooloo, South-west central, South-east central, Pyrmont, and Camperdown. Plague-rats were found in some neighbourhood or other at some date or other on each of them; but it is hardly worth while to continue the illustrations already given in detail of the kind of connection which existed between them and occurrences of plague in man, since the result would merely be to further exemplify what has already been described at length. Yet there is one which presented noteworthy points, of which, therefore, some details may be usefully given.

Camperdown Area.

136. Case 20, occurred in a scene-shifter, employed at Her Majesty's Theatre, who was adjudged to have been infected there, and who was attacked at home during the night of 15th February; he lived at 247, Church-street, Camperdown, and he lay there until 17th February, or for about 40 hours, when he was removed to hospital. He had a right inguinal bubo, morphological test positive; recovered; duration of illness, 23 days. Disinfection of his small one-storey cottage was begun immediately after his removal, and was quickly completed. It was of wood and brick, dilapidated, dirty, damp, rotten, and infested with insects, but free from all traces of rats.

137. A month later—that is to say, on 13th March—Case 61 was attacked at 77, George-street, Camperdown, 7 or 8 chains easterly from Case 20 (see Diagram II). This patient was an old woman, who had not been away from home for a long time past. She had a right axillary bubo, was removed on the third day of illness, and died on the fifth day. Her cottage was of brick and weatherboard, and in a condition which

which rendered it unfit for habitation, so that soon afterwards it was pulled down with consent of the owner. It was very badly infested with rats; the patient's husband said he had removed 3 carcases from his bedroom on 6th March, but also that he had previously laid poison; on raising the floors abundant traces of present infestation were found, and 3 more putrid carcases were removed from under the bedroom floor. On one side of this cottage was a house which had a stable attached to it.

138. In consequence of occurrence of Case 61 a block which was bounded by George-street, Church-street, Burton-street, and Missenden-road was taken in hand by the cleansing staff on 25th March (finished 7th April), which included a produce store at the corner of Missenden-road and George-street. Prior to this the neighbourhood had begun to be searched by the rat staff, but nothing of importance had resulted, except that rats were found in considerable numbers at the produce store just referred to—17 having been caught there by it on the night of 25th March.

139. After a rather long interval, namely, on 21st April, one plague-rat, and on 23rd April, 3 plague-rats, were brought in from the store (search of these particular premises having been intermitted of course, and probably resumed merely because it was a good place at which to catch rats), whereupon the place was closed for cleansing and reconstruction. It included no living apartments; its proprietor occupied a house erected on a low bank at the back of it, entirely detached, and reached by a flight of uncovered wooden steps. Here his wife (Case 127) was attacked with plague on 13th May; she exhibited a right axillary bubo, and recovered. No further carcases were found at the dwelling, which was reported to have been in good order and repair; the store had continued closed from about 25th April, cementing of rubble foundation-walls and concreting of the floor not having been completed until long after attack of Case 127.

140. This instance presents several points which deserve attention. In the first place the neighbourhood was remote from other infected spots, and doubtless received its infection *per saltum*; in that case there is a reasonable presumption, raised by experience on other remote areas already recounted, that it was transported there with supplies delivered at the produce store. Now the owner of the stable next to the house at which Case 61 lay procured his feed from this store. But the dates do not nearly agree. Case 61 was attacked 38 days before a plague rat was found at the produce store, and as far as this point furnishes a hint it suggests that the infection was really travelling the other way—that is to say, easterly from Case 61 towards the produce store, and not westerly from the store to Case 61.

141. Attention is thus drawn to Case 20, which lay still further west of the produce store than Case 61, and to the statement which has been made that the infection is commonly introduced to a clean neighbourhood by man and communicated from him to the rats.* Evidently, from the pathology of plague, this might happen, although reason has never appeared in our experience for suspecting it; and the present instance seems to me not to be one which suggests that sequence of events. For, on those same pathological grounds, a case of bubonic plague of an unusually mild description (the patient was discharged from hospital on the twenty-third day of illness) cannot be supposed capable of diffusing infectious matters during the first 40 hours after the onset, within which term this patient was removed to hospital; his cottage, it will be remembered, having been disinfected immediately afterwards, and finished within less than 72 hours of his first symptoms. There is thus every reason for regarding Case 20 as independent altogether of the two subsequent cases and of the plague-rats afterwards found, and as having been merely one of those imported cases of which so many were met with during the former (as well as during this) epidemic, and from which no communication of the disease either from man to rats or from man to man ever took place.

142. How did Case 61 come to be infected from the produce store since plague-rats were not found at it until 38 days later? There is, indeed, no more than a suggestion that the infection was received thence; and the possibility must be

* See for instance Memorandum on the Influence of Rats in the dissemination of Plague, by W. J. Simpson, M.D., printed for use of the Colonial Office, May, 1900. "Man as a rule is the chief importer of plague into a locality, while the rat at the commencement is the chief disseminator."

be noted that it was carried into the neighbourhood in some quite other and undiscovered way, and that it may have spread gradually from some point much further to the west, perhaps, than even Case 20, through the premises at which Case 61 dwelt, and so towards the produce store. Such conjectures, however, are merely disabling unless they arise in some ascertained probability; and no such probability ever appeared, notwithstanding such a watchful examination and consideration of the circumstances as at the time justified the setting aside of the origin of the infection which the certainly indigenous Case 61 had received as an unsolved problem.

143. We have then to review the data, and on doing so it appears that as a matter of fact there is no evidence that the produce store was free from rat-plague at any particular date prior to 21st April. Even the healthiness of the 17 rats taken there on 28th March must remain doubtful, for at that date only selected rats, and those chosen by the rat-catchers themselves in accordance with rough general rules which have already been mentioned, were delivered at the laboratory; while, as noted above, the premises were not kept under anything approaching continuous observation after failure of the efforts to discover plague-rats in the neighbourhood, which were made immediately on notification of Case 61. Hence this case illustrates the practical difficulties met with in attempting to demonstrate in the field the nature, in particular instances, of the connection between epizoötic and epidemic plague, as much as anything else; and therefore it may be left, after it has been pointed out that Case 127 did not occur in the detached, elevated, cottage behind the produce store, until the latter had begun to be thoroughly turned out in the course of repairing it so as to render access of rats to it less likely, and the burrowing of rats under its floors and about its foundations almost impossible.

Description of a Single Indigenous Case at Newtown.

144. There is also one case, solitary and detached by neighbourhood from all others, which occurred at Newtown; it deserves description, because the discovery of plague-rats once more clearly preceded the infection of man by several days.

145. On 23rd April the Sanitary Inspector to the Local Authority for Newtown delivered at the laboratory two rats which had been picked up in a lane at rear of premises occupied by the Davis Butchering Co., 257, King-street; they presented gross signs like plague, but were too putrid for demonstration of the nature of their disease. On each of the days, 25th, 26th, and 30th April and 1st May, other rats caught or found dead on the premises named were brought in by the Departmental staff to the number of 62, ten of which were ascertained to be infected with plague. No plague-rats were collected from adjoining or adjacent premises; and as soon as the butcher's shop had been closed and handed over to the cleansing-staff, together with the whole block in which it stood, delivery of rats at the laboratory ceased, in accordance with the custom which arose merely in the exigencies of work, and which was designed to relieve the laboratory staff as soon as the fact that the rats on any particular premises or in any cleansing-block of buildings were infected with plague had been firmly established. The shop was of moderate size, in a city street; it was in very bad structural state, and had a small yard entirely built over. The latter contained stables where several horses were kept, annexes used for purposes of the extensive business, and accommodation for the slaughtering of fowls which were temporarily housed there to an average number of about 2,000.

146. There were also in the same block several old premises which had been allowed to stand from times when this suburb was rural until leases should fall in; they were in an indescribable state of disrepair, though presenting to the high road on which they stood shop-fronts which, to the casual observer, were not quite disreputable. All of these were so badly infested with rats and clogged with rats'-dung in every part not habitually walked over that it seemed doubtful whether man or the rats might more justly be deemed to have possession. These shanties were interspersed among many fine buildings which from time to time had been erected on allotments of which the leases had fallen in more or fewer years before; and

their

their continued existence was a disgrace to the Local Authority, who appeared to be ignorant of the ample powers which they possessed under the Public Health Act, 1896, to cause them to be closed and demolished.

Case 108. A. P., m., 54; suddenly attacked 27th April; left femoral bubo; recovered. Was a cabinetmaker employed at 363 Kent-street, with eight others; the shop was in excellent state, and no suspicion ever attached to it. Resided at 245 King street, Newtown, five doors from the Davis Butchering Company, and in the block which was cleansed in connection therewith. Here his family kept a stationer's shop; the building was in bad repair, average cleanliness, and on being taken in hand by the disinfecting staff was found to show abundant signs of being badly infested with rats; but only one carcase was removed from beneath one of the floors.

147. The carcases brought in on 25th April had been soon ascertained with sufficient completeness, under the circumstances, to have died of plague; but time was afterwards lost in attempting to get the Local Authority to do its duty, under supervision, without success; and partly in consequence Case 108 was attacked before cleansing of his premises had begun.

148. Here we see an instance of place infection *per saltum*, and a further instance of precedence of rat-infection over the infection of man. Here, also, is another illustration of our not uncommon experience—namely, that persons exposed on premises where rats are most numerous and are suffering most heavily from plague are, nevertheless, not necessarily the first to suffer, nor even sure to be attacked at all; while persons living in the neighbourhood on premises which show no important sign of presence of epizoötic plague may and do suffer. In short, as we know that plague-rats are not in and by themselves infective for man, so we are compelled by this and many similar examples to assume that the chain of circumstances necessary to bring about communication of this septicæmia of the rat to man is lengthy, and rarely complete in all its links; for though the neighbourhood of plague-rats seems necessary to bring about infection, contact with them is clearly not necessary and, if brought about, does not ensure, nor much increase the probability of, its being contracted.

149. With the two preceding instances, which present features differentiating them from others so far mentioned and worthy of careful consideration, I conclude this exposition of the beginnings of the epidemic, to which accounts of its complete course on certain areas have been added. It does not comprise a reference to every case that occurred, nor a description of the events recorded of every area; but it has been carried almost as far as is necessary to pourtray the usual course of events, and (it is hoped) to place the reader in possession of the general grounds on which we have formed our opinion that epizoötic plague among rats is here a precedent and indispensable condition of epidemic plague. It remains, however, to examine the distribution of cases among houses in relation to alleged spread of the infection of plague from the sick to the well by direct, and by indirect, channels. Before doing so, however, there still remain two occurrences which must not be omitted from description. One concerns plague in man, marsupial and some other animals, and in rats at the Zoological Garden at Sydney; the other a solitary indigenous case at the city of Newcastle. Both of them throw light on the practical management of plague-epidemics; the former also contains some novel observations of interest.

Plague at the Zoological Garden.

150. On 11th April, the Superintendent of the Zoological Garden submitted the intestines and liver of a wallaby for examination in the analytical laboratory. He said that during the preceding six days 7 kangaroos and wallabies, which had been in apparent good health, had suddenly fallen down, become convulsed, and had died after about two hours' illness, whence he suspected poisoning. In the analytical laboratory signs of disease were noticed in the liver, and the specimen was referred to the micro-biological laboratory. By the 18th April it had been definitely ascertained that this animal had died of plague.

151. On that date, therefore, the Secretary to the Trustees was directed to close the Garden to the public, and he was informed that a thorough cleansing and disinfection of the grounds and cages must be commenced at once. The work was carried out under immediate direction of Sanitary Inspectors of this Department, the Trustees having found labour and materials.

152.

152. Before proceeding to describe the course of events subsequent to 15th April, it will be well to mention the organisation which existed, as well as the state of the Garden, at the time it began to be cleansed. The Garden was first established in 1880. It was placed under management of a Board of Trustees. Its income was made up of donations, subscriptions, admission moneys, and a small annual subsidy from public funds, and had never been quite adequate to the reasonable needs of the institution. These facts are mentioned because, although the collection of specimens, the laying out of the Garden, the arrangement of cages and enclosures, and the general appearance of the institution were highly creditable to the Trustees, many and serious defects came to light, of which some could not have been effectually prevented or removed, except at a cost far beyond any resources which ever had been at their command. The Board has now drawn attention to this matter, and has submitted several recommendations upon it to the Government.

153. The Garden occupied a triangular piece of land which measured about twelve acres and a half, and which was enclosed by a galvanized iron fence in bad repair; it occupied the angle formed by the junction of Cleveland-street with Randwick-road, and was bounded towards the north by Moore Park, towards the east by a great extent of park lands, while on its third side there were no houses towards the west for a hundred yards (see Diagram II). The subsoil was blown sand, of great depth. Water was supplied from the public mains; but in the middle of the well-planted enclosure was a small lake, which was filled by surface-waters. The lake was furnished with an overflow pipe, which entered a sluice-box on its bank; the drain from the sluice-box was of 6-inch e.w.g. piping, the mouth of which was defended by a wooden sluice-valve, found on examination to effectually stop it, and said not to have been raised since heavy rain had fallen several months before; it discharged into a covered storm-water drain 30 or 40 chains distant. At beginning of April the pond was already almost dry.

154. About the date at which the unusual mortality among the caged animals began, the collection consisted of between 400 and 500 specimens. The staff comprised 6 keepers, 3 gardeners, a butcher, a gate-keeper, and a carpenter, under a working superintendent (Mr. Holmes). The cages were for the most part arranged around the three boundaries, but not everywhere in single lines; there were, in addition, many aviaries and houses scattered about the inner part of the grounds. There were also a refreshment room, a pavilion for visitors, an office building, and a residence for the superintendent, who was the only member of the staff who slept on the premises. Near one corner of the triangular enclosure was a slaughter-house and boiling-vats; here, also, was a dung-heap, where it had been the custom to accumulate all stable-bedding and refuse for twelve months at a time, with a view to using it at the proper season to enrich the sandy soil.

155. The premises were not connected with the sewers. The public urinals discharged into the sand; other conveniences were furnished with pails, which were emptied by the staff, the contents being utilised about the grounds. Several of the cages occupied by the larger animals drained by e.w.g. piping to the little central lake; but others of them had wooden floors, through which stalings and the like found a way to the under-space, which in some cases was enclosed by brick walls, and was dark and filthy. The enormous dung-heap, then representing about eleven months accumulations, was offensive; and at this part of the grounds were several cottages, or small wooden buildings, which at some time had been in use, but which had become ruinous, filthy, and overgrown with weeds. Near by was the slaughter-yard, which was unsuitably found; although superficially not very unclean, it was in reality extremely foul, and its construction was such that it hardly could have been kept strictly clean. A very large quantity of lumber and refuse was removed from various parts of the enclosure, and burned; and some places were so offensive that the men could work for only a few minutes at a time. In short, it seemed remarkable, under these conditions, that none of those outbreaks of septicæmic diseases, to which animals in confinement are especially subject, had previously been reported.

156. The cleansing operations occupied several weeks, and during the earlier part of them the mortality among the caged animals continued unusually high. Whereas the monthly number of deaths was said to have been generally from 5 to 8, between

between 5th April and 10th June no less than 52 occurred. The bodies of 45 of these animals were examined in the laboratory, with the results described by the Micro-Biologist in the following report. Briefly, in 11 carcases, which comprised 7 marsupials, 1 Indian antelope, and 3 guinea-pigs, plague was demonstrated; in 8 carcases, which included 6 marsupials, although the *post-mortem* signs suggested death from plague, bacteriological tests did not confirm the suspicion; while in the remaining 26 no signs of plague were discovered, 4 of the carcases having been received in too putrid a state, while 10 others furnished clear evidence of some other cause of death.

Bacteriological Report on an outbreak of Plague amongst Animals at the Zoological Garden. By Frank Tidswell, M.B., M.Ch., D.P.H., Micro-Biologist to the Board of Health.

157. It has happened that from time to time the viscera of various animals dying under suspicious circumstances at the Zoological Gardens have been submitted to this Department for chemical analysis. In accordance with this custom the stomach and liver of a Wallaby (Macropus sp.) was brought to the chemical laboratory on April 12th, 1902, but was referred to this laboratory because the liver showed signs of being diseased. On examination this organ appeared to be swollen and softer than natural. It was deeply congested, and showed numerous greyish white necrotic looking areas of various sizes, but mostly about 4 or 5 millimetres in diameter. Smear preparations revealed the presence of numerous bacilli, most abundant in the necrotic areas, but present also in the tissue between them, the appearance of which suggested *bacillus pestis bubonicæ*. The further examination of these micro-organisms gave the following results:—

(*I.*) *Morphological characters.*

158. Bacilli in the original preparations polymorphic, but for the most part ovoid or shortly cylindrical with rounded ends; measuring 1·6–2·4μ long, by ·5 to ·8μ broad. Specimens from cultures were more regularly in form of bacilli and shorter than in the original preparations. Specimens from dry agar cultures showed numerous swollen, rounded or oval, often vacuolated elements (involution forms). In the original preparations and those from solid culture media the individual bacilli were isolated, but preparations from broth showed short chains. In hanging drop preparations most of the elements were quiescent; here and there some were found wriggling, but no change of place occurred. No spores were observed, neither in the original preparations nor in any from cultures or tissues subsequently examined. The bacilli stained readily with ordinary aqueous solutions of fuchsine or methylene blue, showing marked bipolar colouration, but were discolourised by Gram's method.

(*II*) *Cultural characters.*

159. *On nutrient agar* at 36°C. inoculated with the original material, the growth was visible in about twenty-four hours in the form of minute bright dots. During the succeeding few days these became more or less fused into a confluent growth; semi-transparent at the edges, cloudy in the middle. Sub-cultures appeared in about twenty-four hours in the form of faintly cloudy streaks 2 or 3 millimetres wide, sticky. The growths were composed of bacilli possessing the morphological characters described above. *On dry agar* the growth was very scanty and showed numerous involution forms, as already mentioned. *On nutrient gelatine plates* at room temperature, growth appeared in forty-eight hours in the form of colourless dots. Under the microscope the colonies were granular, generally rounded in outline, but showing blunt angulation at different points of the circumference. *In gelatine tubes* the surface streak was whiter than upon agar, and the granular growth appeared for a short distance below the surface in stab cultures. The gelatine was not liquefied. *On Loeffler serum* at 36°C. sub-cultures appeared in twenty-four hours, and subsequently developed into a streak 2 or 3 millimetres broad, thicker than corresponding agar growths. *In bouillon* at 36°C. there was a formation of spicules of growth attached to the sides of the tubes, and a scanty deposit at the bottom; the broth remained clear. Special sub-cultures in flat flasks gave abundant stalactitic growths.

(*III.*) *Pathogenic characters.*

160. Guinea-pig A, inoculated in leg from a twenty-four hours old agar culture, became sick in twenty-four hours, developed a bubo on following day; was comatose on third day, and found dead on morning of fourth day after inoculation. The region of inoculation was swollen, and showed haemorrhagic oedema; adjacent inguino-femoral lymphatic glands swollen, deep red in colour, and surrounded by sanious effusion. Numerous small hæmorrhages under the skin and serous membranes, and in heart, lungs, liver, kidneys, spleen and intestines. Viscera showed general congestion. Liver enlarged, and showed greyish necrotic spots. Spleen enlarged and richly mottled with small grey necrotic spots. Suprarenal bodies deep red in colour. The bacilli above described were abundantly present in the blood and viscera generally, and pure cultures were obtained upon various media inoculated with material from the inguino-femoral glands, liver, and spleen.

161. Guinea-pig B, inoculated from same culture as A, became sick in twenty-four hours; bubo developed in same day; got gradually worse during next two days; was comatose on evening of fourth day, and was found dead on the morning of the fifth day after inoculation. *Post-mortem* appearances of practically same character as guineapig A, but spleen larger and even more richly mottled with greyish areas. The bacilli were abundantly present in preparations from the bubo, liver, and spleen, and were obtained in pure cultures from same organs.

162. Guinea-pig C, inoculated in the leg with scrapings from the liver of guinea-pig A, became sick and developed bubo in twenty-four hours; got gradually worse and died during the fourth day after inoculation. The *post-mortem* appearances were similar to those in guinea-pig A. The bacilli were abundantly present in preparations made from the spleen, liver, bubo, and blood, and were obtained in cultures.

163. A rat—which had been kept in a cage for about a month during which time it remained in apparently perfect health—was inoculated in the leg from an agar culture obtained from original material. The animal was slightly sick in twenty-four hours, grew gradually worse, and died on the fourth day after inoculation. The *post-mortem* examination revealed extensive hæmorrhagic œdema spreading up leg and along abdomen as far as chest. Inguino-femoral glands swollen, and deep red in colour. numerous small hæmorrhages under serous membranes, and in heart, lungs, liver, spleen, kidneys, and intestines; pneumonic consolidation of lungs; liver enlarged to nearly twice normal size, spleen swollen to three or four times normal size; suprarenal bodies swollen and deep red in colour; the peritoneum contained an excess of serous fluid. Bacilli abundantly present in preparations from bubo, peritoneal fluid, liver, and spleen, and obtained in cultures from same organs.

164. The issue of these various observations thus afforded abundant confirmation of the original impression that the micro-organisms in question were *bacillus pestis bubonicæ*.

165. From the date of receipt of the specimen just mentioned (12th April, 1902) up to 10th June, 1902, examination was made of forty-five animals dying at the Gardens. With one exception these animals were subjected to regular *post-mortem* examination, and materials then taken were used to perform a series of tests similar to those described in connection with the first specimen. The observations are briefly stated in the subjoined tabular statement. The heavy pressure of laboratory work prevented the performance of any experiments other than those required to confirm or negative plague, but obvious indications of other diseases are duly noted in the table. (Page 43.)

166. Perusal of the list there given will show that with respect to the results of the examination the animals can be divided into three classes,—

(*a*) Those positively ascertained to be infected with plague; comprising eleven animals, viz., four wallabies, one wallaroo, one pademelon, one tree kangaroo, one Indian antelope, and three guineapigs.

(*b*) Those in which the *post-mortem* signs were suggestive of plague, but the subsequent bacteriological tests were negative; comprising eight animals, viz, New Guinea kangaroo, pademelon, native cat, rabbit-bandicoot, Indian sheep, macaque monkey, and two opossums.

(*c*) Those in which both the post-mortem examination and the confirmatory tests were negative; comprising the remaining twenty-six animals. Of these four, fallow deer, axis deer, opossum, and macaque monkey, were too putrid for satisfactory examination; ten, polar bear, tiger cat, opossum, guinea pigs (2), New Guinea monitor, Syrian goat, Australian eagle, Australian owl, and magpie, showed evidence that death might have been due to other causes, whilst the remaining twelve, macaque monkey, kangaroo rat, native cat, coypu rat, guinea pig, and seven birds, adjutant, flamingo, crane, ducks (3), and marten, gave entirely negative results.

167. It will be seen, therefore, that plague was actually found to have affected seven marsupials, one ungulate and three rodents; that there was unconfirmed suspicion of it in six marsupials, one ungulate and one monkey. For the rest it need only be noted that none of the birds examined showed any signs of plague.

168. It may be added that between dates 16th April and 10th June, 1902, there were examined seventy-six rats taken at the Zoological Gardens, and of these no less than nineteen were found to be infected with plague. As stated elsewhere there was also a case in a human being in connection with this outbreak.

169. The association of plague in the lower animals with epidemics in man forms a noteworthy feature of the older writings upon the disease. Modern observation has shown that many species are susceptible to artificial infection, and that some few, notably monkeys and rodents (rats, mice, bandicoots, squirrels and marmots), acquire plague by natural means. The guinea-pig and rabbit are readily infected artificially, but I believe there is no record of a natural epizoötic amongst them. The carnivora are said to be much less susceptible; cats occasionally take the disease, but dogs appear not to do so. The Ungulata are variably, and in general only slightly, susceptible to artificial infection, and it is doubtful whether the disease is capable of becoming epizoötic amongst them. There is no reference in available records to other species of mammals. Amongst birds, pigeons and domestic poultry are said to have suffered, but the evidence with respect to their susceptibility is contradictory. The data concerning reptiles is equally uncertain; some observers assert, others deny, the susceptibility of snakes, lizards and frogs. There is no available evidence with respect to the fishes. The only records concerning the invertebrata with which I am acquainted report the death of flies, and the presence of the bacilli in, or in the excreta of, ants, fleas, and bugs. As far as I have been able to ascertain the series of cases now reported upon contain, the first recorded instances of the infection in marsupials. The special selection of these animals is interesting in view of the belief in their zoological kinship to rodents.

Table XIX.

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen	Smear Preparations.	Culture	Result of inoculation.		
	1902.								
1	12 April ...	Wallaby, *Macropus sp.*	*Vide* supra	*Vide* supra.				Plague.	
2	17 ,, ..	Fallow Deer, *Cervus dama*, Linn.	Portion of liver; no definite pathological lesions	Liver	N ...	Overgrown	...	Negative	Specimen putrid.
3	24 ,, ...	Wallaroo, *Macropus robustus*, Gould.	Bubo in left inguinal region, suppurating; no hæmorrhages; liver shows numerous small necrotic areas; spleen greatly enlarged and softened	Spleen	N ...	...	...	Plague.	
				Liver	P ...	...	...		
				Left inguinal glands	P ...	...	...		
4	24 ,, ...	Pademelon, *Macropus thetidis*, Lesson.	Bubo of left inguinal region; hæmorrhages in inguinal and axillary regions on both sides, in liver, stomach, intestines, kidneys, suprarenal bodies, and lungs; excess of fluid (sanguineous) in peritoneal and pericardial sacs	Left inguinal glands.	P ...	...	...	Plague.	
				Liver	P ...	P ...	...		
				Spleen	P ...	P ...	...		
5	27 ,, ...	Tree Kangaroo ...	Bubo of left inguinal region; hæmorrhages in inguino-femoral, axillary, and mesenteric lymph glands, heart, lungs, liver, kidneys, suprarenal bodies, stomach, intestines, and into peritoneal membrane; bladder contains blood-stained urine; excess of sanguineous fluid in pericardial and peritoneal sacs	Left inguinal glands.	P ...	P ...	...	Plague.	
				Liver	P ...	P ...	...		
				Spleen	N ...	P ...	...		
6	28 ,, ..	Native Cat, *Dasyurus viverinus*, Shaw.	No signs of disease	None ...	...	...	...	.....	Killed in mistake for rat.
7	20 ,, ...	Kagu Crane, *Rhinochetus jubatus.*	No signs of disease	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
8	29 ,, ...	Kangaroo Rat, *Æpyprymnus rufescens*, Gray.	No signs of disease	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
				Left inguinal glands.	N ...	N ...	...		
9	29 ,, ...	Opossum	No bubo; hæmorrhages in skin, liver, kidneys, suprarenal bodies, stomach, intestines, mesenteric glands, heart, and lungs; excess of clear fluid in peritoneal sac; liver and spleen slightly enlarged	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
10	29 ,, ...	Pademelon, *Macropus thetidis*, Lesson.	No bubo; hæmorrhages in skin, muscle, liver, spleen, kidney, suprarenal bodies, stomach, intestines, mesenteric glands, heart; bleeding from nasal mucous membrane; excess of clear fluid in peritoneal sac; liver and spleen slightly enlarged	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
				Nasal m.m.	N ...	N ...	...		
11	29 ,, ...	New Guinea Kangaroo.	Bubo of right inguinal region; hæmorrhages in skin, peritoneal serosa, liver, spleen, kidneys, suprarenal bodies, stomach, intestines, mesenteric glands, heart, and lungs; bladder contained blood-stained urine; liver, spleen, and mesenteric glands enlarged; lungs show patchy pneumonia; nasal mucous membrane deeply congested; subcutaneous œdema in ventral parts	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
				Right inguinal glands	N ...	N ...	...		
				Mesenteric glands ...	N ...	N ...	...		
				Nasal m.	N ...	N ...	...		
12	29 ,, ...	Adjutant Bird, *Leptoptilus argala*, Linn.	No bubo; numerous small hæmorrhages in bowel, none elsewhere; no definite changes in organs ...	Spleen	N ...	N ...	...	Negative.	
				Liver	N ...	N ...	...		
				Blood	N ..	N ...	...		
13	29 ,, ...	Macaque Monkey, *Macacus sp.*	No bubo; no hæmorrhages, and no definite pathological lesions	Liver	N ...	N ...	...	Negative.	
				Spleen	N ...	N ...	...		
14	29 ,, ...	Polar Bear, *Ursus maritimus*, Linn.	No bubo; inguinal and axillary glands deep red on section; viscera generally congested; lungs pneumonic; animal emaciated and dirty; had been ailing several months; illness said to have started from broken tooth	Liver	N ...	N ...	...	Negative.	Viscera gave streptococcus and pyogenes and staphylococcus pyogenes aureus.
				Spleen	N ...	N ...	...		
				Right inguinal glands	N ...	N ...	...		
				Left ,, ,,	N ...	N ...	...		
15	1 May ...	Owl (Australian Species), *Strix delicatula*, Gould.	Emaciated; no hæmorrhages; general congestion of viscera; had had diarrhœa	Liver	N ...	N ...	...	Negative.	Bacillus isolated; resembled chicken cholera, but not pathogenic to fowls.
				Spleen	N ...	N ...	...		
				Heart-blood	N ...	N ...	...		

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen.	Smear Preparations.	Culture.	Result of Inoculation.		
	1902.								
16	1 May ...	Indian Sheep, *Ovis sp.*	Bubo of right inguinal glands; hæmorrhages in subcutaneous tissue, under peritoneal serosa, in heart and lungs; viscera generally congested; lungs pneumonic; decomposition commenced at time of examination	Liver Spleen Right inguinal glands	N ... N ... N ...	N ... N ... N ...	... ...	Negative	Some bacilli resembling *B. Pestis* in smears, but not confirmed by other tests.
17	4 ,, ...	White Duck	No definite *post-mortem* signs	Liver Spleen Heart-blood	N ... N ... N ...	N ... N ... N ...	.. ..	Negative	Overgrown.
18	5 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet	Lungs pneumonic; no other lesions	Liver	N ...	Mixed	...	Negative	Pneumonia.
19	5 ,, ...	Mandarin Duck, *Aix galericulata*, Linn.	No definite pathological lesions	Liver Spleen Heart-blood	N ... N ... N ...	N .. N ... N ...	... ...	Negative.	
20	5 ,, ...	Wallaby, *Macropus sp.*	Bubo of right inguinal glands; hæmorrhages in liver, spleen, kidneys, suprarenal bodies, skin, lungs, heart, bladder contained blood-stained urine, peritoneum contained excess of fluid; slight œdema of chest wall; liver and spleen enlarged; decomposition commenced	Liver Spleen Right inguinal glands	P ... P ... P ...	Overgrown ,, ,,	P	Plague.	
21	5 ,, ...	,, ...	Bubo of right inguinal glands; hæmorrhages in skin, liver, spleen, kidneys, suprarenal bodies, stomach and intestines, heart, and lungs; bladder contained blood-stained urine; excess of fluid in peritoneal sac; liver and spleen enlarged	Right inguinal glands Liver Spleen	P ... P ... P ...	... ... P ...	P	Plague.	
22	6 ,, ...	Native Cat, *Dasyurus viverinus*, Shaw.	Bubo of left submaxillary glands; hæmorrhages in skin, liver, spleen, kidneys, suprarenal bodies, stomach, and intestines, lungs, and heart; liver and spleen enlarged; decomposition marked	Liver Spleen Left submaxillary glands .. Heart-blood	N .. N ... Mixed N ...	... ...	N N N N	Negative	Bacilli resembling *B. pestis* in smear; not confirmed.
23	7 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet	No pathological lesions	Heart-blood	N ...	N ...	N ...	Negative.	
24	7 ,, ...	Rabbit-eared Perameles, *Thylacomys lagotis*, Reid.	Bubo of left axillary glands; hæmorrhages in skin, kidneys, suprarenal bodies; liver and spleen enlarged	Left axillary Glands Spleen Liver	N ... ... N .. N ...	... ...	N ... N N	Negative.	
25	8 ,, ..	Tiger Cat, *Dasyurus maculatus*, Kerr.	No bubo; hæmorrhages in skin and muscle, liver, suprarenal bodies, heart, glands; no excess of fluid in sacs	Heart-blood Liver Spleen Heart-blood	N .. N ... N ... N ...	N ... N ... N ... N ...	N N N N	Negative	Pneumonia.
26	8 ,, ...	Opossum (brush-tailed).	No bubo; hæmorrhages scanty in skin, suprarenal bodies, heart	Liver Spleen Lungs	N ... N ... N ...	N ... N ... N ...	N N N	Negative	Pneumonia.
27	9 ,, ...	Martin (bird) ..	No signs of disease	Liver Spleen	N ... N ...	N ... N ...	... ...	Negative.	
28	9 ,, ...	Australian Eagle, *Aquila audax*, Lath.	No bubo or hæmorrhages; abscess of left thoracic region; pus cheesy	Heart-blood Liver	N ... N ...	N ... N ...	N ...	Negative.	
29	9 ,, ...	Indian Antelope, *Antilope cervicapra*, Linn.	Left inguinal glands enlarged, and surrounded by sanguineous œdema which resembled bubo; hæmorrhages in skin, liver, suprarenal bodies, and kidneys; stomachs, and intestines, heart, lymphatic glands generally; excess of fluid in peritoneal sac; marked inflammation of stomachs and intestines; decomposition very advanced	Liver Spleen Left inguinal glands.	P ... P ... P ...	N .. N .. N ...	N	Plague ...	Overgrown.
30	9 ,, ...	Opossum *Trichosurus vulpecula*, Kerr.	No bubo; hæmorrhages in skin, inguinal and axillary glands, liver, kidneys, suprarenal bodies, heart; excess of fluid in peritoneal sac; pneumonic patches in both lungs; decomposition marked	Liver Spleen Right inguinal glands Lungs	N ... N ... N ... N ...	N ... N .. N ... N ...	... ...	Negative	Putrid

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen.	Smear Preparations.	Culture.	Result of Inoculation.		
31	1902. 10 May ...	Wallaby, *Macropus sp.*	No bubo; hæmorrhages in right inguinal glands (scanty), mammary glands, skin, stomach, and intestines, kidneys, suprarenal bodies, spleen, heart; excess of fluid in peritoneal and pleural sacs; liver and spleen showed numerous necrotic spots; broncho-pneumonia patches in both lungs	Liver Spleen	P ... P ...	... ...	... ...	Plague ...	Overgrown.
32	13 ,, ...	Mandarin Duck, *Aixgalericulata*, Linn.	No definite *post mortem* signs	Liver Spleen	N ... N ...	... ...	... ...	Negative	
33	13 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet.	*Post-mortem* signs of pneumonia; no indications of plague	Lungs Liver Spleen Heart blood	N ... N ... N ... N ...	... ...	... ...	Negative.	
34	13 ,, ...	New Guinea Monitor, *Varanus sp.*	Abscess in anal region; no indication of plague	Liver Spleen	N .. N ...	N	N ...	Negative.	
35	14 ,, ...	Syrian Goat, *Capra hirsus (var.)*, Linn.	Abscess in left submaxillary region; no hæmorrhages; pneumonic areas in lungs; had been sick for three weeks	Spleen Liver Lungs	N ... N ... N ...	N ... N ... N ...	N N N	Negative.	
36	14 ,, ...	Opossum, *Trichosurus vulpecula*, Kerr.	No bubo; hæmorrhages in right and left inguinal and axillary glands, liver, suprarenal bodies, kidneys, heart; excess of fluid in peritoneal sac; slight inflammation of stomach and intestines; pneumonic patches in both lungs	Liver Spleen	N ... N ...	N ... N ...	N ...	Negative.	
37	16 ,, ...	Macaque Monkey, *Macacus sp.*	No bubo; hæmorrhages in liver, kidneys, and suprarenal bodies; pneumonic patches in lungs; slight enlargement of mesenteric glands near caecum	Liver Spleen Mesenteric glands	N ... N ... N ..	N ... N .. N ...	N	Negative.	
38	17 ,, ...	Axis Deer, *Cervus axis*, Erxl.	No bubo; hæmorrhages in skin, right inguinal, axillary and mesenteric glands, liver, kidneys, suprarenal bodies, 4th stomach, intestines, and heart; excess of fluid in peritoneal sac; serous œdema under skin of ventral surface; decomposition marked	Liver Spleen Lungs Right inguinal glands	N ... N ... N ... N ...	N ... N ... N ... N ...	N	Negative.	
39	21 ,, ...	Macaque Monkey, *Macacus sp.*	No bubo; hæmorrhages in suprarenal bodies; slight enlargement of mesenteric glands near cæcum; decomposition marked	Liver	N	Overgrown	...	Negative.	
40	24 ,, ...	Flamingo, *Phoenicopterus roseus*, Pallas.	No definite *post-mortem* signs	Liver Spleen Heart blood Muscle	N .. N ... N ... N ..	N ... N ... N .. N ...	... ...	Negative.	
41	2 June ...	Magpie, *Gymnorhina tibicen*, Lath.	Acute enteritis	Liver Heart blood	N ... N ...	N ... N ...	... ...	Negative.	
42	5 ,, ...	Coypu Rat, *Myopotamus coypus*, Molina.	No definite *post-mortem* signs	Liver Spleen Heart blood Right inguinal glands	N .. N ... N ... N ...	N ... N ... N ... N ...	N	Negative.	
43	7 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of right inguinal glands; hæmorrhages abundant; superficial left glands generally; skin, muscle, mammary glands, stomach and intestines, liver, spleen, kidneys, suprarenal bodies, heart, lungs; excess of fluid in peritoneal sac; extravasation of blood into epicardium; liver and spleen enormously enlarged and showed numerous necrotic spots; similar spots in deeply congested broncho-pneumonic lungs	Liver Spleen	P ... P ...	P ... P ...	... ...	Plague ...	
44	7 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of left inguinal glands; P.M. signs otherwise same as in No. 43	....	P ...	P ...	...	Plague ...	
45	10 ,, ...	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of submaxillary region; hæmorrhages in skin, muscle, liver, kidneys, suprarenal bodies, heart; excess of fluid in peritoneal sac; spleen enlarged and showed abundant miliary speckling; pneumonic patches in lungs	Spleen	P ...	P ...	...	Plague ...	

170. From the preceding table it appears that the verified deaths from plague among the caged animals occurred as follows:—The first verified death happened on 12th April. During the next 28 days 7 others occurred, and they were separated from the first verified death and from each other by successive intervals of 12, 3, 8, 4, and 1 days. A long interval of 28 days then occurred, during which certain animals died in a number much above the usual average, though not of ascertained plague. Then one of the keepers was attacked (case 135, 5th June) with, and died (8th June) of, plague. The outbreak ended about the same time with three further deaths of animals from plague; these occurred among a small cageful of guinea-pigs on June 7 and 10.

171. Here it may be conveniently pointed out that susceptibility of marsupial animals to plague has now been noted for the first time. Natural infection of caged guinea-pigs has been noted in India.* Another observation worth recording here is the presence of buboes in most of the 11 caged animals which died of plague; our experience being that naturally infected rats never exhibit buboes. The cause of death of the first of them was determined by examination of the liver, which alone was submitted for examination; entire carcases were available in 10 other instances. Of these, 5 showed buboes in the left inguinal, 3 in the right inguinal, and one in the submaxillary glands, while the tenth had the disease in the septicæmic form, and exhibited no enlarged glands. These proportions and distribution were similar to those we have observed in man.

172. Here, then, we have an instance of infection with plague not merely of man, but also of lower animals other than rats. Only a minority of the animals was attacked, just as one only out of the 25 or 30 men working among them was attacked. The man who suffered was not a member of the cleansing-staff, but a keeper who, therefore, would appear to have been less exposed to danger than many others were who, nevertheless, escaped. Again, there was here a long interval of 28 days in the course of the epizoötic among the caged animals, just as we have seen long intervals occur in the course of epidemics (between cases 1 and 2, 1900; cases 1 and 2, and 2 and 3, 1902; on the Paddington and on the Alexandria areas, &c., &c.). These coincidences seem to betoken a similarity between the secondary causes of epizoötic and of epidemic plague. As to epidemic plague, such irregularities can be accounted for by reference to that secondary cause which consists in dissemination of the infection by rats; and I have attempted to induce the reader to observe that some of the more remarkable features of epidemic plague depend upon, and can only be explained by, the capricious way—irregular both in time and in place—in which infected rats gradually become distributed over populous areas which are covered with solidly constructed buildings. Does a similar explanation apply to the peculiar features of this outbreak of plague among caged animals other than rats? In order to answer this question the state of the Garden as to presence of rats, and as to occurrences of plague among them, must be examined.

173. On 21st February (case 25) a complaint had been made that the Garden was badly infested, and was a danger in relation to plague, by one of the public. The Board directed inquiry, and was informed that the place was believed to be comparatively free from rats; this information was unexpected, and afterwards turned out to have been incorrect.

174. On 7th May I examined every member of the Garden staff as to his experience with rats there; but it should be noted that the Superintendent alone slept on the premises, and alone, consequently, had opportunity of observing after sunset when rats were most likely to be visible. The Superintendent said that he had seen increased numbers towards the end of February, but added that during the long term of his superintendency he had noticed fluctuations from time to time, and he declined to attribute any special importance to the increase mentioned. Nevertheless, it appeared from his books that he had purchased an additional supply of traps on 5th March. One of the keepers also said that he had noticed an increase about that time, and had occasionally seen one or two dead rats lying about. Another keeper, whose business it was to attend to some birds, pademelons, kangaroos,

* The Bombay Plague: Compiled under orders of Government by Captain J. K. Condon, Indian Staff Corps. Bombay 1900, page 122.

kangaroos, and wallabies, which were kept in that corner of the grounds where the first deaths among the animals occurred, said that about the time the illness among the marsupials began he had found dead rats, 3 carcases one day, and 2 on another; and this was so unusual a circumstance that he at once reported it to the Superintendent (the Superintendent would not deny, but could not remember, that he had done so). Another keeper, who looked after the elephants and camels in another part of the grounds not far from the slaughter-house, said that, although he had been employed at the Gardens for six years, he had never seen more than a few rats altogether (that is, it will be remembered, by day); but that about commencement of the mortality among the caged animals he had come across a sick rat one day, which he had had no difficulty in stamping upon and so killing. The remainder of the staff, several of whom had been employed for many years, none for less than three, were unanimous in saying that they had not seen many rats at any time, and that they had never, or very rarely indeed, seen a single dead one. There is thus some evidence that one keeper had seen dead rats in unaccustomed number about the time the sickness among the caged animals began, and that somewhere about the same time another keeper saw an apparently sick rat in the open in the daytime.

175. A rat-catcher who had been detailed to secure specimens on 15th April had had very little success, though an experienced and trustworthy man. Between that date and 21st April, when systematic cleansing began, he had been able to submit only two rats, both of which were quite healthy.

176. Specimens were first submitted by the cleansing staff on 23rd April, and down to 3rd May it had forwarded 21 rats, none of which yielded any evidence of infection with plague on being examined in the laboratory. Down to this date the cleansing which had been done had been on the surface; rubbish had been collected, the soil of enclosures had been treated with carbolic acid, and cages and housing-sheds had been sprayed with hot lime-wash: but then some cages began to be moved so as to expose the soil beneath them. As soon as this was done considerably larger numbers of rats were discovered; and 2 out of 7 thus taken on May 3rd were ascertained to have died of plague. So also on 4th May, out of 3 rats one, on 5th May out of 5 rats 3, and on 6th May out of 31 rats 8 were ascertained in the laboratory to be infected with plague. The fact that, notwithstanding superficial appearances and inaccurate information, rats did infest the Garden in large numbers, and that plague was epizoötic among them, having been thus established, routine transmission to the laboratories of all carcases found was intermitted. Hence, although on moving cages and on digging out burrows they continued to be found in numbers, plague was not further demonstrated among them (was not looked for among them) until 7th June. A week or so prior to that date the yield of rats had fallen off, and had almost ceased; and, as has been mentioned already, no verified death from plague had been noted among the caged animals since 10th May, so that there was reason to hope that the infection had been cleared away. But immediately prior to 7th June fresh burrows and fresh carcases of recently deceased rats began to be seen again; they were observed under, and in the immediate neighbourhood of, a cage containing about 20 guinea-pigs. Smoking-out of the burrows with sulphur fumes, and digging-out, were again resorted to, and plague was again demonstrated in 3 of the rats then caught, as well as in 3 of the caged guinea-pigs which died between 7th and 10th June. The total number of rats examined in the laboratories was 76, and it was possible to identify plague in 19 of them.

177. It was thought that this falling off must have been due to some imperfection in the mode of search to that time followed, or to some incompleteness, but, nevertheless, that nearly all the rats and plague-rats must have been destroyed. But this was uncertain; it was therefore resolved that the surrounding fence should not merely be made good as regarded certain holes in it, but that it should be sunk beneath the soil to a depth of at least 2 feet all the way round, so that any rats which might remain should be confined to the enclosure, and so that outside rats should be unable to enter. This work having been speedily carried out, and all detected burrows having been smoked out or dug up without any more plague-rats having been discovered, it was thought that the Garden was free from infection, and permission to reopen it was given on 18th August.

178. It has already been mentioned that one of the keepers contracted the infection. He attended to some of the larger carnivora, of which the cages were on the same side as the guinea-pig cage, though 90 yards away from it; he was attacked on 5th June, and therefore had probably received the infection about 2nd June. He continued to be employed at his own work while the cleansing was going on, so that it would seem that many men (members of the cleansing-staff) had run much greater risks. The following are the particulars of his case:—

Case 134.—B.B., 24, m., single; a keeper at the Zoological Gardens, where he had been employed for three years and down to date of attack. His duty was to feed and clean some of the larger carnivora, wolves, wombats, and Indian swine. He had worked daily, Sundays included; occasionally he had done a little gardening, but not for several weeks before his illness. He lived at a house half-a-mile away, and left the Garden at night-fall. He was attacked at 3 30 on the afternoon of 5th June, with violent shivering, colic, vomiting, and diarrhœa. His case was reported about midday on 6th June, and he then exhibited a left inguinal bubo; presence or absence of wounds in relation to the bubo was not noted. In view of the circumstances I directed bacteriological examination of liquid withdrawn from the bubo to be made, and both morphological and cultural tests yielded positive results. He was removed the same day to hospital, and died 8th June. Specially careful examination was directed to be made of the house at which he lived. There were mouse-eaten holes in skirting boards on the ground-floor; all ground-floors were raised, but no traces of rats were found. Rat-catchers were told off to catch rats on the premises, but failed. The other inhabitants said that similar efforts had been made without success a few weeks before by rat-catchers in employment in this neighbourhood by the Local Authority for the City. At this house there were three contacts; there were no further cases, either there or at the Garden.

179. B.B. had had no communication with any previous case of plague, according to the result of inquiries on this head.

180. How had the Garden become infected? The larger carnivora were fed on horses which were slaughtered on the premises. The rest were fed on fodder which was furnished by a contractor, who procured his supplies by rail from the country; they were not distributed from his place of business in the Darling Harbour area, but were purchased by the Superintendent on the trucks in the railway yard, and were carted thence direct to the Garden. The same, I was informed, might be said of the maize, bran, pollard, potatoes, barley, and chaff, which formed other part of such supplies. Lastly, carrots, greenstuff, bananas, and some bread were supplied by a Chinese gardener at Botany. The information on these points was not precise, and probably represented merely the general rule.

181. The house nearest to the Garden at which a case of plague occurred stood 16 chains away. This was Case 100, and it occurred in a school boy who was attacked 18th April; he exhibited a left inguinal bubo; morphological and cultural tests positive; recovered. The house in which he lived with his parents was in bad sanitary state, and in poor repair; there were stables close to it; it offered every evidence of present infestation with rats; the inhabitants said they had complained to the Local Authority before the child's illness of bad smells in it as from dead rats, and the disinfecting staff removed 3 carcases from beneath the floors when they came to raise them. The nearest house beyond this at which any case of plague occurred was 60 chains away to the south-west, the next 84 chains away to the north-west; all others were still more remote, and the intervening country entirely covered with buildings. The nearest point at which a plague-rat had been taken was 72 chains away to the south-west. The patient was said not to have been away from his neighbourhood for many days before his attack, except on 6th April, when he had paid a visit to the Zoological Garden; but this, supposing the date correct, was 12 days before his attack, and, consequently, from 7 to 9 days before the date of his infection.

182. It thus seems possible that the last-mentioned patient's house became infected by invasion of plague-rats from the Garden, but also that the Garden was infected by invasion of city rats which travelled towards it across the area on which that house stood. If the latter had happened, it would be singular that no cases of plague in man, except this one, should have marked the progress of the rats, while on the other, it would not be surprising if migration in the contrary direction should have given rise to this one case alone. On the whole, our experience inclines us to favour the supposition that the Garden was infected first, and through imported fodder; but conjecture alone is possible.

DESCRIPTION OF A SINGLE INDIGENOUS CASE AT THE CITY OF NEWCASTLE.

183. Newcastle is situated at the mouth of the Hunter River, in S. latitude 32° 57′, 70 miles north of Sydney by sea. The population of the city municipal district was 14,250 at the Census of 1901, that of the city and adjacent suburbs 32,225. The tonnage entered during 1901 was 1,573,683. The principal occupation followed was coal-mining. One case of plague had been met with on a vessel in the port on 17th March (or five months before) which was imported from Sydney, and which has been elsewhere described (see p. 15).

184. T. O'N., 19, male, single, a native of this State, had been employed at the Criterion Hotel as cellarman and porter for four months; he had not been away from the neighbourhood during that term. He was quite well until he was suddenly attacked during the afternoon of 3rd August with severe headache, chilliness, and pains in the limbs. He went to bed, and on 4th August was visited by a medical man who advised his removal to the general hospital, where he was admitted the same day. During the ensuing night he was delirious, and on the morning of 5th August he had a temperature of 104°; he was seriously ill but nothing could be discovered to account for his condition. During the evening he first complained of pain in his left leg, and later an acutely tender swelling was observed in the left chain of femoral glands. Early on 6th August the case was reported to the Medical Officer of Health for the Hunter River Combined Sanitary Districts (Dr. Robert Dick, M.B., D.P.H.). Dr. Dick at once telephoned to the Department his clinical opinion that the disease was plague, and the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.) was despatched to Newcastle to consult on the case with him. He arrived during the evening, and on the 7th expressed his concurrence with Dr. Dick's opinion. At a later hour Dr. Dick was able to report that the morphological and cultural tests which he had applied to liquid abstracted from the enlarged femoral gland had both yielded positive results, and afterwards that a guinea-pig which had been inoculated with a part of the same liquid had died of plague. Nurses having experience of plague were at once sent up, and all arrangements for transferring the patient to the Maritime Quarantine Station at Stockton were completed; but at the same time he grew rapidly worse, and he died at the general hospital on 7th August. The body was coffined with the precautions already described (Report, 1900, p. 21), and was buried on the Maritime Quarantine ground.

185. The Criterion Hotel was closed on 6th August, as soon as Dr. Dick's message had been received. It was placed under a police-guard instructed to prevent ingress of all but members of the household and lodgers. Dr. Dick was desired to obtain a list of names of all then living at the hotel, and to ascertain whence they had come; and as soon as all had been collected to inform them that they would be allowed to leave, but to permit none to go until their effects had been disinfected and their professed destinations ascertained. The licensee's family numbered 6, his servants 10, and the lodgers 18. The latter were almost all of them commercial travellers, and none had been out of the State for a long time past; many of them resided in Sydney, and none had had any discovered connection with plague there, where the last case had been notified two months before, on 12th June. All the visitors but one left on 7th August; no case occurred among them or at the hotel. As soon as the particulars mentioned had been ascertained egress and ingress were allowed to the occupants without any restriction.

186. After a preliminary inspection of the premises on the evening of 6th August, the Medical Officer of Health had reported the finding of a dead rat in a state of decomposition too far advanced for any useful examination, and that the licensee had said that shortly before T.O'N.'s illness he had found other dead rats. On 7th August the foreman of the Departmental rat-staff was directed to proceed to Newcastle, there to gather together a local rat-staff of twelve men, who were to catch rats in such neighbourhoods as might be pointed out from time to time by the Medical Officer of Health. Chief Sanitary Inspector Getting was also directed to proceed to Newcastle on the same date, taking with him apparatus and material necessary for immediate disinfection of the patient's room and the lodgers' luggage. He was accompanied by Temporary Sanitary Inspector Lobb, previously employed on similar duty at Sydney, and he was instructed to gather together a scavenging staff for cleansing of the premises, and of the neighbourhood afterwards.

187. At the same time the Mayor of Newcastle, as representing the Local Authority under the Public Health Act, for the City of Newcastle (with whom the Medical Officer of Health had already communicated), was officially informed of the nature of T.O'N.'s disease, and of the arrangements made for obviating the danger to which the city was exposed; and his assistance in furnishing labour and materials was requested. An advertisement was also forwarded for insertion in all the Newcastle newspapers, in which medical practitioners were requested to be good enough to refer doubtful cases with which they might meet to the Medical Officer of Health.

188. On 8th August, the hotel was occupied by the cleansing-staff. It was a large three story brick building, which stood at the corner of Hunter and Bolton streets, in the centre of the business part of the city. As a whole it was clean and well kept, and there were no signs of rats on the upper floors. But a large cellar under the bar was very dirty. It had a poor concrete floor, which was undermined by rats in all directions, and considerable quantities of rats' dung and rat rubbish afforded abundant evidence of recent infestation. It contained two shallow wells, apparently designed to collect subsoil waters draining from a steep rise on which the hotel stood; the upper well overflowed into the lower. The overflow from the latter escaped by an untrapped 9-inch e.w.g. pipe, which ran underground straight down the hill to the harbour front, where it discharged under wharfs at a distance of 9 or 10 chains from the hotel. This cellar was the principal place at which the patient was employed during the day; and it was learned that he had removed 8 dead rats from it shortly before he fell ill. During the cleansing 4 other carcases were discovered in it, but they were all too far advanced in decomposition for bacteriological examination. No live rats were observed.

189. At the wharves under which the drain discharged very large quantities of fodder had been landed during several previous months, either from ships or from the railway which ran along them; this had in large proportion been sent up from Sydney for transmission to the north, where it was wanted in consequence of a prolonged drought. It was almost or entirely the produce of this State, heavy duties having prevented profitable importations; but it had, no doubt, been exposed to incursions of rats during its collection at Sydney, where the last discovered plague rat had been taken on 11th July.

190. As soon as cleansing of the hotel, and of an adjoining ship-chandler's shop, which as regards rats was structurally one with the hotel, had been begun, a further cleansing gang was collected and organised by the Chief Sanitary Inspector, and it was placed under immediate supervision of temporary Departmental Sanitary Inspector Lobb, who had with him the Municipal Sanitary Inspector Lloyd; they were further assisted by Sanitary Inspector Abberton, of the personal staff of the Medical Officer of Health who directed the proceedings.

191. Authority of the Executive Government had already been procured for entering and cleansing the whole of the block which included the Criterion Hotel, and in the course of the next few days this work had been completed. The Local Authority then proceeded, as advised, to make a sanitary inspection of several other adjacent blocks in that part of the city which lies between Signal Hill and the railway viaduct, a distance of about 68 chains.

192. Destruction of rats had been carried on at Newcastle prior to the events now described. During the thirteen months, 11th May, 1900, to 8th June, 1901, a capitation grant of 6d. had been offered, and a furnace at which the rats brought in could be burned had been provided at a convenient spot; the number then paid for and destroyed was 32,581. This arrangement was resumed on 6th March, 1902, but the capitation grant was reduced to 3d.; between that date and 16th August, 13,103 rats were paid for and destroyed. During the four weeks ending 9th August the numbers thus brought in had been 255, 167, 169, and 83. The special rat-staff organised on 8th August was utilised, not for destruction of rats (although, of course, it incidentally destroyed them), but to collect them systematically from various neighbourhoods indicated by the Medical Officer of Health, so that the state of the rat-tribe generally on the area suspected of infectivity might be investigated. It began work on 8th August, but was not at its full strength of twelve men until 13th August. Between 8th August and 11th September it collected

rats

rats from 125 different premises which were well distributed over the whole area, many of them having been revisited several times. The number of rats collected was 1,598, and all were examined by the Medical Officer of Health. Two carcases alone gave ground for suspicion of plague; but the usual tests which were applied both by the Medical Officer of Health and by the Micro-Biologist to the Board of Health failed to establish presence of the disease. It must, therefore, be recorded that no plague-rats were found at Newcastle. Nevertheless, for reasons which have already been given above, it cannot be affirmed that there were no plague-rats there; and it is a significant fact both in relation to infection of T.O'N. and to arrest of it after occurrence of that single case, that no rumour of unusual mortality among the rats of any part of Newcastle was heard during the investigation, except at the Criterion Hotel.

193. No further cases of plague occurred, nor were any cases which presented good grounds for suspicion subsequently reported to the Medical Officer of Health.

Distribution of Cases among Plague-houses.

194. We are now in a position to examine the facts in relation to possible direct or indirect communication of the disease from man to man as a cause of the epidemic prevalence of plague more closely. The question, indeed, was examined fully in relation to the first epidemic (Report, 1900, pp. 31–33), and was in the clearest way answered in the negative; it will be well, nevertheless, to go over the evidence yielded by the second epidemic in order that this contribution to the ætiology of plague may be complete in itself, as far, that is to say, as it goes.

195. The following general statement has reference to houses which *harboured* cases, without regard to their having been or not having been the adjudged place of infection of such cases. The epidemic consisted in 139 cases; the patients inhabited 124 premises (including one ship); 15 out of the 139, therefore, were secondary cases. As the 15 secondary cases occurred on 9 premises, it follows that 115 separate premises (including one ship) harboured a single case apiece, and no more. The interval between attack and removal, or the number of days during which these 115 patients remained at home and in contact with the other members of the households to which they belonged was as follows:—

Table XX.—Showing the number of days after attack during which 115 primary-and-single cases remained in contact with the rest of the household to which they belonged:—

Removed on the day of attack	2
„ one day after attack	20
„ two days „	24
„ three „	24
„ four „	17
„ five „	8
„ six „	4
„ seven „	3
„ eight „	3
„ nine „	2
„ ten „	3
„ eleven „	1
„ twenty-three „	1
„ twenty-six „	1
Not removed	2
Total ...	115

Whence it appears that these 115 patients had, for the most part, opportunity of communicating their disease. Table XX corresponds with Table XII, Report 1900, p. 33, which is to precisely similar effect. Communication of the disease from person to person, if it ever occurred at all, was a factor of no importance whatever in production of the epidemic. We have, however, to examine the circumstances under which the 15 cases mentioned above occurred secondarily to, and on the same premises as, 9 primary cases.

Circumstances under which Fifteen Secondary Cases became Infected.

196. The datum for examination of the circumstances under which secondary cases received their infection, with reference to the possibility of their having got it from the primary case, is the time at which the primary case fell ill.

Table XXI.—Showing the dates on which nine primary cases began, and the dates on which fifteen cases secondary to them began.

Group.	Primary cases.—Numbers and dates of attack.	Secondary cases.—Numbers and dates of attack.
A	(3) Jan. 10–11	(5) Jan. 16.
B	(6) Jan. 19	(8) Jan. 20.
C	(24) Feb. 18	(30) Feb. 21.
D	(26) Feb. 19	(29) Feb. 21; (27d*) Feb. 22; (32d) Feb. 22; (31d) Feb. 23; (39) Feb. 24; (40) Feb. 25.
E	(35) Feb. 22	(45d) Mar. 1.
F	(52) Mar. 11	(53) Mar. 11.
G	(82) Mar. 21	(92) Mar. 29.
H	(85) Mar. 27	(91) April 2.
I	(112d) April 27	(117d) May 3; (126d) May 15.

* d = died.

197. *Groups A and B* (Paddington area).—These have been described elsewhere (see p. 22). Here only the following points need be mentioned:—First, Cases 3 and 5 of Group A were, of course, in intimate contact for ten or nine days of duration of Case 3; but the latter exhibited a right inguinal bubo, was at no date seriously ill, and recovered. Cases 6 and 8 of Group B were in contact for about twenty-four hours of duration of Case 6; the latter exhibited a left inguinal bubo, and recovered. Additionally, one or both of the patients constituting Group B had visited Case 3 one or more times. Secondly, the two groups occurred in adjoining cottages, which were separate for man, but structurally one for rats infesting either; and both were structurally one by the space under the floors with a third adjoining cottage, at which, as well as at the other two, it is known that a fatal disease prevailed among the rats infesting it.

198. *Group C* (Woolloomooloo area).—First, it must be assumed that there was free communication between Case 30 and Case 24 during the three days which elapsed before the latter was removed, since, although they belonged to different families, both inhabited the same small house. But Case 24 exhibited a left femoral bubo, and ended in recovery. Secondly, the house at which both lived was badly infested with rats, which, also, had recently died in numbers of disease; thirteen had been found dead between 15th and 17th February—four of them under the kitchen floor, one in the water-closet. Now, Case 24 was probably infected on 16th February, but the illness was not notified till 21st February; this was the day Case 30 was attacked, prior to which no cleansing had been done.

199. *Group D* (Criterion Hotel, Central area).—This group, according to Table XXI, consists of seven cases; but Case 27 was not secondary to Case 26, nor the remaining five secondary to Cases 26 and 27, for these two patients had left the hotel (where they had lived) before they fell ill. They are retained in the Table below partly to avoid confusion, but mainly for the sake of the light they shed on the true nature of the relationship between Case 29 and the remaining four. The following Table conveniently sets forth the important points. It is only necessary to emphasise the facts that Case 26 had acted as a temporary barmaid at the hotel, sleeping on the premises, from 10th February to 17th February; she had left in good health on the latter date, and was taken ill two days later at a house in a neighbourhood free from suspicion of infection, and without having had any further communication with the six later cases; and that Case 27, who had lodged at the hotel for several months before, left it on 19th February in good health for another hotel (which has never been suspected of infection), where she was attacked three days later.

Table XXII.—Showing the dates on which the seven patients who constitute Group D were attacked, notified, removed, and recovered or died; together with the situation of the buboes they exhibited.

Case No.	Sex.	Attacked.	Notified.	Removed from "Criterion."	Clinical form.	Situation of bubo.	Date of—	
							Recovery.	Death.
26	F	February 19	February 22	Had left 2 and 3 days before the attack.	Bubonic	R. inguinal	March 18	.....
27	F	,, 22	,, 22		,,	R. cervical	.....	March 2
29	F	,, 21	,, 22	February 23	,,	L. femoral	March 24	.....
31	F	,, 23	,, 24	,, 26	,,	R. inguinal	.....	Feb. 27
32	F	,, 22	,, 24	,, 25	,,	R. inguinal	.....	March 1
39	F	,, 24	,, 24	,, 26	,,	L. femoral	April 7	.....
40	M	,, 25	,, 26	,, 26	,,	L. inguinal	March 27	.....

200. It must be assumed that there was communication between Cases 29, 31, 32, and 39 after attack of Case 29, since they were all women living at the same hotel; but Case 40 occurred in a cellarman, and it is not likely he saw any of the women after they had been attacked. Nothing is known on this point. What were the other circumstances?

201. The premises were the Criterion Hotel and Theatre. They consisted of a fine corner block, four stories high, with a basement, of which part of the ground floor frontages was let as shops, &c. The three upper floors were clean. The ground floor and basement were in bad repair and dirty. These latter were ceiled and floored with wood, and subdivided with wooden partitions. When cleansing began and the partitions and linings were torn down, enough dung and rat's rubbish (paper, bones, rags, &c.) were removed to nearly fill two large scavenger's carts. Provision for drainage was inadequate, several inches of water having been found standing under the false floor of the ill-lighted and ill-ventilated compartments in the basement, some of which served as sleeping apartments for the servants. A similar state of things existed under the flooring of the first floor as regards rat's dung and rat's rubbish, of which large quantities were removed from between the joists. Upper floors had been gnawed through by rats at many points. From different parts of this building about forty-five dead rats were taken—from behind lining-boards and from under flooring boards in the basement; beneath kitchen, scullery, and pantry floors; from under a bedroom floor near a dining-room on the first floor; and from under three bedroom floors and a passage floor on the second storey. A bar-floor was riddled with rat-holes, and three carcases were taken from a box-seat behind the bar, another from under the counter, another from an adjacent urinal. All these carcases were too putrid for bacteriological examination, and no live rats were encountered; hence plague was not shown to have been the cause of this unusual mortality, which clearly had occurred during a few days only, since the carcases were in about the same stage of putridity. But plague was at this date present among the rats of the neighbourhood (*see* Central area, par. 133).

202. It is now apparent that the bond between Cases 26 and 27 severally and the remaining five was residence on these premises, and nothing else; for they were only attacked two and three days respectively after having left them for lodgings to which no suspicion of infectiveness at any time attached—one of them two days before Case 29, which was the first of the subsequent series. Next, it can be pointed out that Case 29 began 21st February, and that the four subsequent cases followed at intervals of one, two, three, and four days; but Case 29 not only exhibited a left femoral bubo and recovered, but also was removed within forty-eight hours of her attack. Note that Case 40 had in all probability received the infection on or before that date on which very energetic cleansing and disinfection of these premises had begun—namely, late on the afternoon of 22nd February.

203. *Group E* (Alexandria area).—Case 35 exhibited a left femoral bubo, and ended in recovery; during four days of its duration, Case 45 was in free communication with the patient. The house was a two-storey brick cottage in poor repair, where a pawnbroker's business was carried on. On being cleansed, large quantities of rat's rubbish and droppings were removed from beneath the floors which, as well as the skirting-boards, were full of rat-holes, but no carcases and no live rats were seen. There were many burrows in the yards, none of which were dug out. The neighbourhood was infected (*see* Alexandria area, par. 108). The second case may either have received its infection from rats which had been left in the burrows, or the house may have been reinfected from the neighbourhood after such cleansing as was done.

204. *Group F* (Central area).—The patients were a pantryman and a waiter employed at the Central Exchange Coffee Palace for a considerable time before attack. Both fell ill on the same day, one having been suddenly attacked "while at work," the other at 10 p.m. The premises were very extensive and constituted one end of a city block, having, consequently, frontages to three streets. The greater part of it was occupied by an hotel and by a photographer; other part as offices; the frontages at street level as shops. All parts of the building were in structural communication, so as to be free to rats. Sewerage was defective. A well, intended to light inner rooms of the building, had been filled with staging and covered over; the roof had been extensively built upon by the photographer, who had erected a very large number of rooms of odds and ends of wood, and had even built on the top of them again, the whole being full of lumber, dirt, and rubbish, except some filthy places in use. On cleansing, most parts of the building were found to be infested with rats, and large numbers of carcases, as well as nests, rubbish, and some live rats, were removed, but no plague-rat was identified. The two patients were partly employed in the basement, but slept in a kind of loft which was much overcrowded with ten other servants, and dark at midday. On the night they were taken ill, eighty people slept at the hotel, but no other cases occurred (but *see* Table XVII, in which Cases 60 and 69 are doubtfully ascribed to this building, which they visited regularly as an eating-house). There was here no possibility of communication of infection from Case 52 to Case 53 (nor from either of them to Cases 60 and 69, since the latter only went to the hotel about midday, while the former were suddenly attacked at night and incapacitated, and were removed during the forenoon of the next day, when, also, the building was closed to visitors).

205. *Group G.*—The first patient (Case 82) was a wharf-labourer in irregular employment; he fell ill 21st March, but worked on 24th and 25th March notwithstanding; he exhibited a left inguinal bubo, smears and cultures negative, and recovered; was removed to hospital, 27th March. The second patient was his son, aged 6, who fell ill eight days after him, and two days after his removal; glandular swellings, bi-cervical, acutely tender (slight reddening of fauces; no exudation) and bi-inguinal, of which slight tenderness on one side only; bacteriology, none; recovered. No note as to state of premises, which stood on the Chippendale area, the house being close to Jones's produce store at the back (*see* par. 84).

206. *Group H.* (*Pyrmont area*).—This was composed of Cases 85 and 91, mother and son. Case 85 was attacked 27th March, at 11 a.m.; left femoral bubo, smears and cultures negative; recovered; removed to hospital, 29th March. Case 91 occurred to the son, who was a printer's boy; no suspicion attached to his place of employment, which was carefully examined. He was attacked 2nd April, during the morning

at

at his work, six days after his mother, and four days after her removal; left femoral bubo, which appeared within four hours of onset; bacteriology, none; recovered; removed on day of attack. The cottage was cleaned on 29th March, the day Case 85 was removed; on taking up floors abundant signs of present infestation were found and much rat's rubbish removed, but no carcases; at least one dead rat had been found by the family a few days earlier. Next door to this house Case 83 had occurred 26th March. The patient was a labourer; he had a left femoral bubo, and a small reddened patch on the left instep, no pustulation; bacteriology, none; removed 27th March. A dead rat had been found by the patient a week or two before, but no carcases were found by the disinfecting staff. Case 85 was acquainted with this man, but said she had not been in his house for a week before his illness—a matter of little importance, true or not true, on account of the nature of his case and of his removal within twenty-four hours of his attack. But it seems that the disinfecting staff had not raised the floors at his house; for on occurrence of Case 91 they did this, and reported presence under them of every sign of continued infestation with rats, though they found no carcases. These three cases occurred on the Pyrmont area. On 26th March a plague-rat had been taken from the yard of a State school situated 160 yards away from these two cottages to the south-west, and three plague-rats were taken at Buckle's wharf on 7th, 8th and 10th April, which lay about 380 yards away from them to the west. No other case occurred within three-quarters of a mile of the cottages except Case 78, attacked 24th March at a rat-infested timber-wharf where many dead rats had been found; and Case 99, attacked 17th April, and Case 124, attacked 6th May, both at Buckle's wharf just mentioned.

207. *Group I.*—This consists of Cases 112, 117, and 126, which occurred in Chinese, all of whom died. The first of them was a man employed at Hop Lee & Co.'s produce store, 26, Campbell-street, on the South-Central area (and already mentioned, see par. 100); he was attacked 27th April, had the disease in septicæmic form, and died before notification at the entrance to Sydney Hospital to which he was in course of removal by his friends. Case 117 was attacked 3rd May; was admitted to the Royal North Sydney Hospital from a Chinese garden on that side of the harbour; his case was notified on 7th May, on which day, also, he died. He had pneumonia on admission and a submaxillary bubo, smears and cultures positive. This man had frequented Hop Lee & Co.'s during the week before his attack, and there seemed to be no doubt that he had also slept there; he was thus on the premises during illness of Case 112. Case 126 was attacked 15th May; the patient was taken to Sydney Hospital 16th May, but died on the way; nature of illness verified *post-mortem* under Coroner's order. This man was employed at Hop Lee & Co.'s. On notification of Case 112, the store was visited by the disinfecting staff, and was found to be well-constructed and in good order, but there were ill-lighted and ill-ventilated cubicles within the building, and more on the flat roof of a stable in the yard; abundant traces of present infestation with rats were found, but no carcases. The Local Authority for the city was advised to secure removal of the cubicles, but this was not done at that time owing to some misunderstanding. On occurrence of Case 118 the store was not revisited, for this patient's connection with it was not made out until after occurrence of Case 126; but it was revisited on occurrence of the latter, and although, again, no carcases were discovered, abundant signs of continued infestation were observed, and especially fresh droppings among pea-nuts stored over some of the inside cubicles. It has already been noted that a plague-rat was taken at a public-house six doors removed from this store on 22nd April (see par. 100).

208. These facts require no comment. It need hardly be pointed out that Group G presents elements of doubt as to the nature of the two cases, though the diagnosis was made and was confirmed by two physicians acting independently, both of whom had had long clinical experience of the disease; still it is to be regretted that no bacteriological check was applied to the second of them. In Group H the clinical signs were decisive; the negative result of the bacteriological examination which was made in Case 85 only was probably due to some accident, such as failure of the needle to penetrate a small bubo. I proceed to describe the instances in which multiple cases occurred in connection with premises at which none of the patients resided.

Circumstances surrounding the Infection of Four Groups of Persons associated solely by resort to the same Premises.

209. The foregoing groups, A to I, were made up of persons who lived at the premises where all of them are adjudged to have been infected (save two persons in Group A whose cases, as already noted, properly belong to this series; see par. 199). The following groups are composed of persons who in no instance lived at the place at which they are adjudged to have received the infection, but, on the contrary, all inhabited different houses in neighbourhoods which (with one exception) were distant or even remote from it, and which were also free from suspicion of infection with plague. In other words, the sole tangible bond between the persons of which these groups are severally composed was resort during business hours to the same business premises. Group K has special interest, since of the four persons composing

it,

it, while two were employed at the theatre which was the adjudged place of their infection, two others merely attended a performance at it. The following table displays the more important facts :—

TABLE XXIII.—Showing the dates on which persons who constitute Four Groups, distinguished solely by resort to the same business premises, were attacked, together with some other particulars.

Group.	Case number and date of attack.	Adjudged place of infection.	Nature of association at and with adjudged place of infection.	Place of Residence.	Area in which residence situated—whether infected or not.
K	(21) Feb. 12	Her Majesty's Theatre and Hotel, 186–8, Pitt-street.	Attended performance.	Nelson-st., Leichhardt ...	Not.
	(18) „ 14		Employed ...	130 Reservoir-st., Surry Hills	„
	(19) „ 14		Attended performance.	22 Bullanaming-st., Redfern...	„
	(20) „ 15		Employed ...	247 Church-st., Camperdown...	Not till a month after attack.
L	(34) „ 24	Siddaway's Boot Factory, 47, Market-street.	Employed ...	59 High Holborn-st.... ...	Not.
	(43) „ 27		„ ...	Bondi	„
M	(64) Mar. 14	Andrew's Printing-house, 13, Bridge-street.	„ ...	38 Campbell-st, Balmain ...	„
	(65) „ 15		„ ...	14 Phelps-st., Surry Hills ...	„
	(66) „ 16		„ ...	26 George-st., Erskineville ...	„
	(71) „ 16		„ ...	Bexley	„
	(70) „ 17		„ ...	Kogarah	„
N	(99) Apr. 17	Buckle's Wharf ...	„ ...		
	(123) May 6		Frequented Buckle's Wharf.	6 Ultimo-st., Ultimo... ...	Yes.
				289 Riley-st.	Not.

210. *Group K (Central area).*—Her Majesty's theatre and hotel. The premises were very large, and had frontage to Pitt and to Market Streets. The theatre and the hotel were in communication for man only by a bar which was open to the latter on one side, to the dress circle on the other. This was not used as a passage. But for rats, these two establishments were practically one.

211. Case 21 occurred in a woman who was attacked 12th February, and who lived in a suburb 3 or 4 miles away, at a brick and weatherboard cottage, which was in fair repair, very clean, and free from all traces of infestation with rats. The patient said she had not been away from the neighbourhood of her dwelling for a long time prior to her attack, except 10th February, when she attended an evening performance at the theatre with her husband; they then sat in that part known as the family circle. No "indigenous" case occurred at any time within a mile of her residence.

212. Case 18 occurred in a boy who was regularly employed at the theatre, and who was attacked 14th February. His chief duty was to clean bottles and to keep in order a store-room at the back of the gallery next above the family circle, and in the evening to attend at a refreshment bar at the back of the family circle; he also sometimes helped to clean the auditorium. He went to this work at 7·30 a.m., continued till 4 p.m., went home and returned for the evening performance at 8 p.m., lastly getting home to bed at about 12·30 a.m. He lived in a brick terrace house, clean, in fair repair, and found to present no signs of infestation with rats.

213. Case 19 occurred in a man who was attacked 14th February. He was unemployed at the time, and from his account of his movements, which seemed to be straightforward and consistent, it appeared that he occasionally (though on what dates in relation to his illness, if any, was not made out) took food at 178, Pitt-street; that is to say, next door to No. 180, where a plague-rat was taken on 14th February. He lived in a brick house which was found to be dirty, damp, and in bad repair, but quite free from all traces of infestation with rats. No indigenous case occurred anywhere in the neighbourhood of his dwelling. On 11th February he went to the theatre, and then sat in the family circle.

214. Case 20.—This patient, who was attacked 15th February, was employed at the theatre as a scene shifter; he worked in the flies, and these were accessible both from the family circle and from the gallery; he was last employed on the day of his attack. For a description of his cottage and the state as to plague of the neighbourhood in which it stood, see Camperdown area (par. 136).

215. The theatre was separated from shops to the north of it on the Pitt-street frontage by a blind lane; the hotel kitchen was in the basement, and had a passage which led to this lane, by which wastes were taken out and deposited in boxes to be emptied by the scavengers; but similar access to the lane could be had from one or more premises to its north. From this lane putrid carcases had been gathered on 29th, 30th, and 31st January, and on 1st, 8th, and 11th February; and although almost unfit for bacteriological examination some of them were submitted to it. The general result was, that while morphological tests yielded doubtful, but occasionally apparently positive results, all cultures quickly became overgrown, and all

all inoculations yielded doubtful and untrustworthy results. Clear *primâ facie* evidence of plague in these carcases was got on 3rd February for the first time, and this was confirmed by the results of inoculation tests on 7th February. Further, plague-rats were taken on 14th and 25th February at premises within ten doors of the lane and on the same side of the way, namely, at No. 180 Pitt-street; so that it is plain that the neighbourhood of the theatre was freely infested with rats, among which plague was prevalent. Lastly, it need not be doubted that the plague-rats taken in the lane were thrown out from the hotel kitchen, perhaps altogether, but at least in part.

216. It has already been stated that, although ostensibly separate buildings, the theatre and the hotel were practically one for rats; especially, these animals had burrows which passed from the basement of the theatre, under the party wall, into the basement of the hotel where the kitchen was. But in general respects the two premises were found to be in good order. The sewerage and all the internal fittings had been reconstructed in 1900; the theatre was clean and, except the burrows referred to in the basement, no traces of rats were found until the family circle was reached; there cushions were both moth- and rat-eaten, and two carcases were removed from beneath the staging which supported the seats. In all, eight carcases were removed from the upper part of the theatre. In the wall of the family circle there was also a chase which carried a hot and a cold water-pipe, and a waste-pipe from a bath-room in the hotel, and which contained rubbish; under the floor of the bath-room two more carcases were found. However, the hotel was also found to be in good order and very clean except the basement, which was dirty; seven carcases in all were gathered from it. Lastly, the pavement in front of the theatre and hotel in Pitt-street, where it abutted against the external walls, was undermined by rats, these having gained access from a dry area. The undermining also extended in front of the Pitt-street face of the George Hotel a quite separate building which stood on the actual corner, and which was embraced by the theatre building, consequently, on two sides; here Case 22, attacked 16th February, occurred in a handy man, and on cleansing, although the place was clean and in good order, seven or eight putrid carcases were removed from it, as well as a good deal of rat-rubbish.

217. *Group L.* (*Central Area*).—Cases 34 and 43, attacked 24th and 27th February, occurred in two bootmakers employed at Siddaway's boot factory, 47, Market-street. These premises were less than 100 yards from Her Majesty's Theatre; it was not noted whether the two patients worked in the same part of this large establishment. The first of them lived about a mile away in a house which was free from all signs of infestation, and in a neighbourhood which yielded no indigenous cases; the second in a suburb several miles away which has at no time harboured any other case of plague, and in a house which was clean, in perfectly good order, and free from all signs of infestation. The first patient said that eight dead rats had been found and removed during a few days prior to his attack, and on cleansing the factory abundant traces of present infestation were found, and many carcases were removed from it.

218. *Group M.* (*North-central Area*).—This consists of five cases which occurred in men employed at Andrew's printing-house, 13, Bridge-street. All of them lived at houses which were ascertained to be rat-free; three of them in neighbourhoods at distances of from 1 to 3 miles, two of them in suburbs reached only by train at distances of 7 or 8 miles. The two latter had never harboured any case of plague, and no reason had appeared for suspecting that two of the former three were at any time infected. But the printing-house was riddled with rat-holes from basement to the top story; a history of dead rats found shortly before, and of the capture in traps of large numbers of live rats, was given by the workmen; eighteen carcases were removed by the disinfecting staff, and from between floors and ceilings, behind matched-board linings, and from other such places, no less than thirty-five loads of rat's dung, rat's nests, and general rat-rubbish were removed.

219. These and one other were the only premises in connection with which cases of plague occurred on the North-Central area, and it is convenient to refer here to Case 129, attacked 15th May, that is to say, two months later than any of the foregoing. The patient was a packer employed at a very large hardware store, who lived in a railway suburb which had never harboured any case of plague. The store was extremely well built and kept; all basements were of concrete, and all apertures were fitted with wire netting to aid in excluding rats. It had on one side of it a lane, on which Andrew's premises abutted. The latter were in so exceedingly bad a state that they were closed, and were repaired in a very leisurely way in consequence; so that at the date of attack of Case 129 rubbish was still being removed from them by way of the lane, which, of course, gave access to the hardware store as well. Careful inquiry revealed no other source of danger in Case 129; but it is quite possible the patient ran risks elsewhere.

220. *Group N.* (*Pyrmont Area*).—This consists of two cases which were separated by an interval of nineteen days. One was employed at, the other frequented, Buckle's wharf, at which plague-rats had recently before been taken, namely, on 7th, 8th, and 10th April, and from a wharf close by on 12th April; previously Case 78 had been attacked on 24th March, having been employed at a timber wharf next to Buckle's, where dead rats had been found in number. These were Cases 90 and 123. The latter patient, who had inhabited rat-free premises in an uninfected neighbourhood for thirteen days before his attack on 6th May, frequented this wharf for the greater part of a week before going by sea to the north of the State; he fell ill the third day after leaving. The little steamer in which he travelled had not only been fumigated and freed from rats before her departure, but was also on her first voyage; only two or three rats had been found on her. The wharf was in fair condition, but large quantities of produce as well as live pigs were landed there, and pig-yards and some stables were ill-constructed and dirty.

221. The last of these four groups, though probably entitled to its place in the list, is not as convincing as the other three, which, on the whole, furnish evidence of connection between plague-infection and premises, and between infective premises and presence of diseased rats, as good as can be desired. All the sufferers were

were united by one common circumstance, and by one only, namely, resort to the same rat-infested premises; in each group all were taken ill within three days of each other; none lived in infected neighbourhoods; and although it is true that all of them were free to visit infected neighbourhoods, yet the attack of all at about the same date excludes that explanation of their infection; lastly, no secondary case occurred at any of their places of residence, as distinguished from the adjudged places of their infection. So that while it is quite impossible, on the one hand, to surmise how it happened that the components of the three groups respectively came to be attacked at the same time, unless reference be made to the places of business to which they resorted; on the other the infection of plague is clearly enough shown to have existed in those places by the discovery of the carcases of dead rats in unusual number, and at a similar stage of putrefaction, at a time at which plague is known to have been epizoötic among the rats of the several neighbourhoods.

222. In connection with this short series (which corresponds with the series of 17 similar instances given in the Report, 1000, p. 35, Table XIII, but in much less detail) Case 14, Paddington area, should be recollected; in which the patient, who lived at a distance, fell ill rather less than three days after having cleared away rat-rubbish and two putrid carcases from beneath the floor of the house at which Case 13 had occurred.

Part III—The Epizoötic in relation to the Epidemic.

Introductory.

223. In all accounts of epidemic plague which have hitherto been published, the following causes have been recognised as efficient: (a) communication of the infection from the sick by direct and (b) by indirect means; (c) place-infection. By the two former the infection would be diffused, by the latter maintained.

The term "place-infection" is employed below in the sense in which it is used in India; this has has been mentioned above, (par. 36).

It seems to be now very generally admitted that communication of the infection from the sick occurs so rarely in the bubonic and septicæmic forms of the disease, that it might well be neglected in speaking of epidemic plague. But the singular lapse (pointed out by Hankin nearly five years ago) by which sufferers are regarded as no source of danger to others while they stay at home or at a near hospital, and yet are commonly regarded as the conveyors of the infection to clean places if only they travel away from home, seems (from the report of the Plague Commission in India; see also the footnote at page 37) to be still unrepaired. Nothing further is needed to show that the aetiology of plague is still a matter of doubt with a large majority.

224. These causes would amply suffice, of course, to explain the epidemicity of plague; and thus far the share which may be borne therein by rat-plague has been left in a position of undefined importance.

225. To refer to well-known reports on plague by English writers for example, the "History of the Progress of Plague in the Bombay Presidency from September 189[illegible], to June 1899," although it contained very full references to Mr Snow's observations on migrations of rats and coincident spread of the epidemic in the same directions, nowhere suggested that the rat was the sole important cause of epidemic plague, and at the same time did rely on the other causes of spread which have been mentioned above. Secondly, the Report of the Indian Plague Commission, dated July 1901, merely admitted that sometimes rats might spread plague, and throughout represented direct or indirect communication of the infection from the sick and place-infection, as the prime causes of epidemic plague. Lastly, the Medical Officer to the Local Government Board, in his preface to Reports and Papers on Bubonic plague by Dr. Bruce Low, dated July 1902, discussed this relationship to which, he said, Dr. Bruce Low had given particular attention, and after consideration of the world-record submitted to him concluded that although it went "to confirm

"belief

" belief that, as regards plague, man and the rat are reciprocally infective, fail " completely in affording sufficient data for determining the degree to which man is " in danger through the rat."*

226. The difficulty of perceiving how the infection could be often conveyed from rat to man weighs heavily with some, no doubt, against the probability that epizoötic plague stands in causative relation to epidemic plague; yet at a very early date the practical efficiency of the rat in disseminating this infection oversea was generally asserted and admitted.

227. Nevertheless, Hankin had reviewed† certain epidemiological data in 1898, which had been gathered at Bombay, and had inferred that the incidence of plague on neighbourhoods and on houses stood in relation to their accessibility to rats, and not to any other of the several factors then and still commonly relied upon as secondary causes, such as filth, overcrowding, &c. &c.; and he had at the same time intimated his opinion that some intermediary insect was necessary to communicate the infection from rat to man. In the same year Simond,‡ after reviewing epidemiological data concerning the mode of spread of plague gathered in India, expressed his opinion that its epidemicity was due to migrations of plague-rats and not to human intercourse; at the same time he named the flea (and the bed-bug; but with the latter he was unable to experiment, and he assigned little importance to it *a priori*, having been apparently unaware that these insects are found in great numbers on rats, at all events in some parts of the world) as the intermediary insect which he, as well as Hankin, conceived to be necessary. Simond's hypothesis of the flea has indeed attracted very general attention, and perhaps there is now hardly anyone who is not aware of it, although in reality it was a secondary part of his paper. These contributions by Hankin and by Simond appear to me to be the only *epidemiological* contributions which have thrown much light on the aetiology of plague; and their weight lies, not in any theory as to the manner in which the infection is communicated from rat to man, but in exclusion, so far as their observations went, of infection derived from man as an efficient cause of epidemic plague. But this was overlooked, and the aetiology of epidemic plague remained obscure and, indeed, in confusion.

228. This result has followed in part—but, as the papers by Hankin and Simond have shown, in part only—from plague having occurred most often in eastern and other semi-civilised communities where accurate epidemiological observations hardly can be made. Hence the outbreak at Sydney in 1900 afforded a good opportunity of learning something exact of the mode in which plague spreads, from its having happened among a wholly civilised, white population, which lived under the same conditions of clothing and housing, of food, customs, social organisation, and local government, as are found in the cities of Europe. The Department was prepared to take advantage of it (see Report of the Board of Health on the case of A. P., Sydney, 7th February, 1900; or, Report 1900, Appendix L., in which the more important parts of that document were reprinted). Before occurrence of the first case (that of A. P.) inferences had been drawn from the reports so far published of the epidemics which had occurred or which were in progress in other parts of the world which differed in important respects from the opinions expressed by the historians themselves. By those inferences the action of the Board was guided, as has already been mentioned. And when the observations made and recorded during that outbreak came to be reviewed, it appeared that epidemic plague at Sydney had not been caused in any degree either by personal transmission of the infection, or by dissemination. of fomites; and while it was rendered quite clear that place-infection could have played but an insignificant part at most in maintaining the infection, it seemed most probable that it had in reality played no part at all.

The only parts of the world, as far as I have seen, in which our observations of 1900 have been repeated by others, are Brisbane in Queensland, and Port Elizabeth in Cape Colony; at both of these places they seem to have been practically confirmed. At Brisbane, Dr. Halford§ during the epidemics of 1901 and 1902, and at Port Elizabeth, Dr. Blackburne‖ during the earlier half of 1901, were both able to exclude

* I much regret to find myself compelled to point out here that the account of plague in New South Wales which is given in the volume referred to (and of which I am in the best position to speak authoritatively) is erroneous in almost every detail of importance. † Annales de l'Institut Pasteur, 1898. ‡ *Ub cit. sup.* § Report on 117 case of plague occurring in Brisbane in Sporadic Form; by the Medical Officer to the Metropolitan Joint Board, Brisbane, Q., 1902. ‖ Lancet, 11th October, 1902.

exclude diffusion of the infection by man, and to trace association between cases of plague and plague-rats as clearly as could be reasonably expected. Both, however, committed themselves to statements concerning the connecting link between rat and man which, it is most important to note, had not been at that date sufficiently supported by direct evidence, as I have myself elsewhere pointed out.*

229. These results constituted a step of which the importance has hardly been appreciated (W. Kolle alone, as far as I know, has perceived their bearing and weight: see Bericht über die Thätigkeit in der zu Studien über Pest eingerichteten Station des Instituts für Infectionskrankheiten, 1899–1900, Zeit. f. Hyg., 1901, p. 397). If under conditions which admitted of accurate observation the generally accepted causes of epidemic plague were seen not to have been in operation, some other cause was to be sought. For what had been thus pointed out was not merely the result of interference with the natural course of the disease by good management—such, for instance, as is implied in prompt removal of patients to hospital, and in prompt disinfection of their dwellings; nor could it be ascribed to generally favourable conditions of housing, feeding, work, and climate. Although it might fairly be argued that the comparative smallness of the total number of cases was due to those factors, yet the cause of the absolutely large number (303) which did occur still remained to be discovered. It was certain that the infection had not been diffused and maintained by man; how then had it been spread? Place-infection having been excluded by the facts, but one other means presented itself, and, in my opinion, but one other could be reasonably surmised. This was the rat, in whose body, and in whose body alone out of all places external to man's body, the infection had been shown to be commonly present.

230. If man commonly received the infection from the rat—if epizoötic plague were indeed the cause of epidemic plague at Sydney; then coincidence between plague-rats and plague in man on the same premises should be demonstrable, and (it seemed, *a priori*), easily demonstrable. But in the course of the review referred to we found that we had not demonstrated it. Dr. Tidswell had, indeed, been enabled to identify but 23 plague-rats throughout the epidemic, and none of them were obtained from premises which had yielded cases of plague in man. Or, if findings of putrid carcases in which the nature of the disease, which, evidently, had been the cause of death, could not be rigidly identified, be accepted as evidence of epizoötic plague (as under all the circumstances it reasonably may), then dead rats in number were only observed on about 70 premises, although 221 premises were the adjudged places of infection for 255 cases. But the reader who has perused the foregoing pages need not be told that, so far, at all events, there is no evidence that this discrepancy was a matter of fact; clearly it may have been apparent only, and may have resulted from the method of observation, which was certainly imperfect.

231. On recurrence of the disease in 1902, then, we were prepared by former experience to examine this relationship more closely, as well as to check the correctness of our earlier observations on the share taken by man, fomites, and place-infection in diffusing and maintaining the disease. It has already been shown that former conclusions regarding these factors have been completely confirmed. Besides this, further continuous observation and reflection have completely failed to suggest any other source of the infection than that furnished by diseased rats.

232. The ground, therefore, seems to be thoroughly cleared. All that remains is to inquire whether during the second epidemic improved methods of observation did or did not reveal such frequent and close association between plague-rats and plague in man as suffices to furnish a strong presumption that diffusion of plague-rats was the sole cause of the epidemic.

233. From the method of description selected, the reader is now in a position to judge in how far the connection referred to has been discovered, and in how far it deserves to be recognised as the essential condition which we are convinced it was. Here it is necessary only to mention a few numerical statements, to refer briefly to the more cogent facts already related, to trace the course of the epizoötic, and to advert to the conditions of observation in the field which—and which alone, I think—have caused the results, although improved upon those attained in 1900, still to remain defective. TIME

* Public Health, Vol. XIV, pp. 340-1.

Time and Place Relations.

234. In the first place, the following table, which necessarily begins with the epidemic of 1900, exhibits a certain general relationship in time between epizoötic and epidemic:—

Table XXIV.—Showing month by month the number of plague cases which occurred, and the number of plague-rats which were identified, during the epidemics of 1900 and of 1902, together with the interval which elapsed between the two; as well as a part of the plague-free time which followed on conclusion of the second outbreak.

Year.	Month.	No. of Persons infected.	No. of plague-rats identified.	Period.
1900...	January	1	.....	First epidemic.
	February	3	9	
	March	51	2	
	April	107	6	
	May	93	5	
	June	41	1	
	July	6	.....	
	August	1	.....	
	September	.....	.....	
	October	.....	.....	
	November	.....	.....	
	December	.....	.....	
1901...	January	.....	.....	
	February	.....	.....	
	March	.....	.....	
	April	.....	.. ...	
	May	.....	.....	
	June	.....	.....	
	July	.....	.....	
	August	.....	.....	
	September	.....	.....	
	October	.....	.....	
	November	1	4	Second epidemic.
	December	1	.....	
1902...	January	6	5	
	February	26	25	
	March	57	6	
	April	20	37	
	May	22	23	
	June	6	4	
	July	.....	1	
	August	.....	.....	
	September	.....	.....	
	October	.....	.....	
	November	.....	.....	
	December	.....	.....	
1900–2 Totals...	... ...	442	128	

235. In 1900 only 187 rats, selected from a recorded take between 18th April and 31st October, 1900, of 108,308, were examined in the laboratories. During the first interval (September, 1900, to November, 1901) only 237 were examined. From 16th November, 1901, to 31st March, 1902, the recorded number of rats taken by the Departmental staff and by the public (who again received a capitation allowance of 3d.) was 47,285, from which 1,730 were selected by the Departmental staff in accordance with the rough rules already mentioned (see par. 81), and were examined in the laboratories; 40 of them were found to be infected. From 1st April onwards all rats taken by the Departmental rat-staff were delivered at the laboratories, and were examined; the number from 1st April to 14th July, when the last plague-rat was identified, was 28,618, and 65 were found infected. From July 13th to December 31, rats collected from the wharf line within the city, from the city proper, and from adjacent municipalities, to the number of 25,664 were collected, and 12,051, being all that were taken by the Departmental staff, were examined in the laboratories; none of them were infected. From 1st January to 31st March, 1903, rats to the number of 4,254 were collected from the wharf line within the city, and from closely adjacent streets of the city only, and 3,952 were examined in the laboratories; none of them were infected. That is the evidence of general coincidence in time between occurrence of plague in man and finding of plague-rats.

236. It is also the evidence that at Sydney it did not appear that plague in a chronic form persisted among the rats after the apparent epizoötic had ceased.

237.

237. Secondly, the table below shows a general coincidence in place between occurrence of cases and findings of plague-rats.

TABLE XXV.—Showing the *indigenous* cases of plague which occurred in each of the 8 wards of the City of Sydney and in forty metropolitan municipalities, the number of rats collected in each district, and the number of plague-rats identified in each collection :—

	First Epidemic. 19th January, 1900—9th August, 1900.			Second Epidemic. 4th November, 1901—8th June, 1902.		
	Cases.	Rats.		Cases.	Rats.	
		No. Examined.	No. Infected.		No. Examined.	No. Infected.
CITY OF SYDNEY.*						
Bourke Ward	24	21	2	8	558	5
Brisbane „	56	28	13	12	1,759	17
Cook „	14	14	1	3	1,258	19
Denison „	31	14	.....	14	2,454	14
Fitzroy „	2	4	.....	2	1,080	2
Gipps „	16	9	.....	3	773	4
Macquarie „	22	4	1	28	600	13
Phillip „	14	1	1	12	261	4
SUBURBAN MUNICIPALITIES.						
Annandale	4	1	.....	.....	2	.....
Alexandria	.....	.....	.....	8	317	4
Ashfield	.....	.....	.....	.....	.....	.....
Balmain	.....	.....	.....	.....	565	.....
Bexley	.....	.....	.....	.....	.....	.....
Botany	.....	.....	.....	.....	150	.....
Botany North	.....	.....	.....	.....	48	.....
Burwood	.....	1	.....	.....	2	.....
Camperdown	2	.....	.....	2	332	5
Canterbury	.....	.....	.....	.....	.....	.....
Concord	.....	.....	.....	.....	.....	.....
Darlington	.....	1	.....	.....	233	.....
Drummoyne	.....	.....	.....	.....	3	.....
Enfield	.....	.....	.....	.....	.....	.....
Erskineville	.....	.....	.....	.....	66	.....
Glebe	6	.....	.....	.....	285	.....
Hunter's Hill	.....	.....	.....	.....	11	.....
Hurstville	.....	1	.....	.....	.....	.....
Kogarah	.....	.....	.....	.....	2	.....
Lane Cove	.....	.....	.....	.....	3	.....
Leichhardt	1	1	.....	.....	.....	.....
Manly...	9	48	3	.....	28	.....
Marrickville	.....	.....	.....	.....	15	.....
Marsfield	.....	.....	.....	.....	.....	.....
Mosman	.....	.....	.....	.....	7	.....
Newtown	.....	1	.....	1	346	12
North Sydney	.....	3	.....	.....	144	.....
Paddington	20	5	.....	9	1,120	3
Petersham	.....	.....	.....	.....	1	.....
Randwick	.....	1	.....	.....	17	.....
Redfern	25	2	2	1	946	1
Rockdale	.....	.....	.....	.....	5	.....
Ryde	.....	.....	.....	.....	.....	.....
St. Peters	.....	.....	.....	.....	15	.....
Strathfield	.....	.....	.....	.....	.....	.....
Vaucluse	.....	.....	.....	.....	1	.....
Waterloo	10	.....	.....	10	687	2
Waverley	3	3	.....	.....	90	.....
Willoughby	.....	.....	.....	.....	29	.....
Woollahra	5	15	.....	.....	45	.....
TOTAL	264	178	23	113	14,258	105†

* At the end of 1900 the city was divided into 12 wards. The earlier arrangement has been retained in this Table for purposes of comparison.

† Found on 40 inhabited houses (dwellings or places of employment), at 13 wharves, and in 6 streets, lanes, &c. ; or at 59 different places in all.

238. From some part of each of the 8 wards into which the city proper is divided (total area 2,880 acres, number of houses 21,137), all of which yielded cases, and from some part of each of those 6 of the 40 municipalities comprised in the metropolitan district which yielded cases of plague, plague-rats were collected. No plague-rats were got from districts in which no indigenous cases occurred. Neither were any got from districts into which cases had been merely imported; the extent to which the search was carried in such districts is shown in the sixth column of the preceding Table.

239. With assistance of the details already given (see Mode of Spread, p. 18), the general indication afforded by this table can be supported a little more directly. Thus, although Alexandria and Waterloo have a combined area of 1,830 acres, which carries 3,947 houses, the findings of plague-rats were confined exactly to those neighbourhoods in which the cases of plague were found; or, although Paddington has an area of 403 acres, which carries 4,386 houses, plague-rats were found only on that very small part (of about 16 acres, carrying 163 houses) which has been named the Paddington area, where the 9 (or 11) cases which constituted that sub-epidemic were found. Again, Camperdown covers 435 acres, and carries 1,503 houses, but plague-rats were identified only at premises in that street where the two indigenous cases of plague were met with. So also at Newtown, where the municipality covers 442 acres, and contains 4,521 houses, the only case of plague which happened there was found within half a dozen doors of the butcher's where a local manifestation of the epizoötic occurred, and at the same date. There is good evidence, then, of close association in place between plague cases and plague-rats.

240. Yet some evidence is required of closer association between cases and plague-rats; that is to say, of an association demonstrable in a preponderating proportion of individual cases. But the fact as regards such association is that whereas 113 cases have been adjudged to have been infected on 86 separate premises, and although plague-rats were identified on 40 inhabited premises (be they dwellings or places of employment), plague-rats and cases coincided but 4 times. Or, should that way of judging the facts be thought too rigid (as I have no doubt it is), then it can be stated that cases and the removal by the disinfecting staff of dead rats from the premises which were the adjudged places of their infection coincided only 47 times. This is a considerable proportion, though not large enough to be quite satisfactory; yet, although it may not be expanded, a much fuller statement of certain facts should be added to it, and considered in connection with it.

Notes on General Experience with the Epizoötic.

241. Experience has led us to regard the finding of several carcases at about the same stage of putrefaction on any premises, as evidence that disease has been at work (poison having been excluded). Further we recognise as evidence of death by disease not merely the carcases themselves, but the fact that they were found; for though rats die in the ordinary course from day to day their bodies are rarely discovered, and are even rarely a cause of nuisance. It has to be borne in mind, therefore, that the above-mentioned proportion of plague-houses from which dead rats were removed is ruled by the requirement that in order to form acceptable evidence of disease several carcases must be found; but for this precaution the proportion of such premises to indigenous cases would stand higher. Secondly, the evidence of infestation of premises consisted in rat-holes, rat-runs, and rat-rubbish (paper, bones, rags, straw, &c.) accumulated between floors and ceilings, between double partitions, and in other such places; while evidence as to recency of the infestation was furnished by the state as to moistness of the rats'-dung discovered, as well as by the actual finding of rats or of comparatively fresh carcases. Then, there was strong evidence of infestation in the case of 61 places of residence, of 23 places of employment, and of both in 3 others; that is to say, all these patients either lived or worked, or both lived and worked, in close association with rats, while in the case of 47 adjudged places of infection it was plain that the rats had lately been killed by disease. That disease was identified with plague on premises which yielded plague-

plague-cases 4 times only; the carcases having been in all other instances too far advanced in putrefaction for that rigid bacteriological examination which alone, I consider, warrants use of the word "identified."

242. Here it should be additionally noted on the one hand that a minority of total premises are rat-infested, and on the other that the presence on inhabited premises of plague-rats is far from being necessarily accompanied by cases in man. For instance, no cases occurred in connection with 36 of the 40 inhabited premises mentioned above on which plague-rats were identified; and Jones' store (par. 84) affords a striking example of this. But I have already pointed out that after examination of all the available facts it appeared that mere association with plague-rats does not suffice, apparently, to infect, and that "something further, and something not commonly existent, seems necessary to enable communication of the infection from the source to man . . ." (Report, 1900, p. 36). Our more recent, and more fully recorded, experience likewise obliges us to suppose that infection with plague is the result of a chain of circumstances which, on any individual premises, is seldom complete in all its links.

243. If epizoötic plague stand in causative relation to epidemic plague it must precede the latter. It is probable that this was the case in 1900, but we did not actually ascertain it. Probably it was the case in 1902, but, again, it was not actually ascertained. The bare facts are that Case 1 was attacked on 4th November; that a rat search began on 16th November; and that a plague rat was taken at one of a line of wharves, at which produce was habitually landed, on 18th November: while the case occurred in connection with a produce store at which presence of a fatal epizoötic among the rats which infested it was observed on 14th November, which epizoötic was proved to be plague. Yet it is hardly possible to mistake the meaning of this chain of events, although they do not constitute a proof. The patient certainly did not infect the rats at the store, for he was suddenly taken ill shortly after reaching it for work as usual, and immediately went home again. It is quite clear, however, that plague among the local rats preceded the occurrence of cases on the Paddington area; on the Alexandria area it must have done so, because, on examination of the patient's store within 48 hours of his attack, only putrid carcases in considerable numbers were found; some other and similar instances have been already mentioned above. Again, it was ascertained to have preceded attack of all cases together (except the first, which very strictly speaking must be excepted for want of demonstrative proof) and by five weeks or thereabouts.

244. It is now necessary to remind the reader that all these gaps in the evidence are not defects in fact, but evidently are due in a large measure—I think they are entirely due—to those practical difficulties which have already been mentioned (see pars. 114–5–6). It was said above that it had appeared, *a priori*, that coincidence on premises of the disease in rats and in man should be easily demonstrable. That such a coincidence did occur very often I do not doubt; but, after making prolonged attempts to follow the course of the epizoötic by methods which were modified from time to time, I am able to assert that this business is an exceedingly difficult one in any city. Briefly, the only methods of search thus far appearing to be practically available ensure, almost exclusively, the capture of healthy rats. The reasons have been sufficiently explained above. We must resort, then, to the teaching of those instances in which multiple cases occurred either at places of residence or at places of employment. Similar instances constituted the most weighty part of the Report on the Epidemic of 1900, in relation to the point under consideration; but those now referred to, having been much more minutely recorded, speak, I think, unmistakably. I do not hesitate to say that the case of the Criterion Hotel, Central area, alone would warrant a confident assertion that the doubts and hiatuses which the record of the epidemic in general and on particular areas shows, must be the result solely of inacquaintance with all the circumstances. This, however, must be left to the reader's judgment, to which it is submitted without hesitation.

245. I conclude this section with a record of some general observations on the course of the epizoötic. Transport of the disease *per saltum* has already been noted. From the centres of infection thus established it spread, as observed in 1900,

by

by continuity; and, since it can be thus transported, it follows that any district which has become infected thus or otherwise may be reinfected, or infected in another part of it, by the same means at some later date; and it may be thus reinfected not merely from the local *fons et origo* (which we consider was in both of our epidemics that particular line of wharves on the eastern shore of Darling Harbour, which—again, we consider—was on both occasions infected from places oversea), but also from any other infected district with which it is in the requisite kind of communication. The requisite kind of communication, or that which is most favourable to transport of the infection, appears, as a matter of observation, to be the distribution of fodder.

246. Plague is commonly represented as spreading among the rats of a district with extreme rapidity, and as exterminating them almost. Contrary to reported experiences in many other countries, sick rats have not been often seen in the open at Sydney. The instances cited by more or less trustworthy witnesses were not more than four during 1902, and with one exception it was said that only one sick rat at a time had been seen. Figures which have been given already show that the finding of plague-rats by the ratcatchers (particular premises being excepted, and reference made merely to buildings and their curtilages which were examined in the ordinary course of the night's work on infected areas) was not common. On certain badly-infested premises the disease has been seen to rage, and to exterminate the horde apparently—at Exton's, and Huxley's, and Goff's stores, for instance. In those cases the epizoötic was apparently over as regards those houses before the examination began. In another instance—at Jones's store—it seems that early information enabled the examination to be begun before the outbreak had long existed. Not merely were live rats found in number; but carcases were fresh, and there was no difficulty at all in identifying the disease. Rats usually retire from places where the horde has met with misfortune; but from this it would seem that they do not always do so quite so promptly as has been supposed. But such findings of carcases in great numbers were few, and were entirely confined to badly-infested, confined premises; while the carcases picked up in streets and lanes were almost always putrid, and beyond reasonable doubt had been thrown out from premises on which they had died. Here, then, we have seen the epizoötic rage with exterminating violence; but the case of the "Antillian" goes to show that very close quarters (or some other circumstance, possibly of quite another kind) are necessary. The outbreak among the comparatively few rats which that vessel carried—probably not more than 100 originally—appeared to be still in course of making slow progress when it was detected.

247. Then, again, we have no evidence of rapid spread over neighbourhoods. Cases of plague, of course, most certainly draw attention to the state of the local rats, and plague among the latter is (we think) attended by cases in man only in a small minority of instances; so that it is probable that a larger proportion of rats was affected than we have actual evidence of.

248. On the whole, the following opinion may be ventured:—The disease is much more frequently communicated from rat to rat than it is from rat to man, or from man to man (which latter is so uncommon as to be negligible, if primary plague pneumonia be excepted); and as the disease in the rat is a septicæmia, it can hardly be much more easily communicable between rat and rat by mere contact than it is between man and man, of which, also, laboratory experience affords direct evidence (see Further Observations on the Mode of Infection, p. 65). Hence I suspect that, as in the case of man, some special circumstance is requisite. I do not know what this is; but Dr. Tidswell has been struck in this connection with the fact that during the epizoötic fleas were abundant on all the rats brought to the laboratory, while as soon as evidence of its continuance had failed, fleas became so uncommon on the rats, which were still brought in in large numbers, as to be quite insufficient for purposes of the laboratory collection (see Ecto-parasites of the Rat, p. 71). The abundance of fleas on rats during continuance of the epizoötic was not specially associated with illness of the animals; it was generally observed, and on those which were perfectly healthy as well as on others.

Species of Rats Affected.

249. As to the species of rats affected, Dr. Tidswell has made the following note:—

With the exception of a single specimen of the Australian water-rat (*Hydromys*), which was found to be perfectly healthy, all the rats received belonged to one of two species—*Mus decumanus* and *Mus rattus*. No record was kept of the actual numbers of each. In the whole collection there were about as many of one as of the other; but *Mus rattus* predominated among those taken along the shores, and *Mus decumanus* among those taken inland. The infected specimens were all *Mus decumanus*. The rats taken from the "Antillian" were all of this species. I have not found plague in *Mus rattus*, although this species was readily infected in the laboratory.*

Mode of Infection.

250. After association between plague-rats and cases in man has been demonstrated sufficiently often to furnish a strong presumption that the epizoötic might have stood in causative relation to the epidemic; and after this presumption has been strengthened by the observation that whenever there was reason to believe that the important facts were fully known the epizoötic preceded the occurrence of cases in man, a difficult problem presents itself. This is, how the infection can be communicated from rat to man; and, after that has been shown, how it can be so communicated sufficiently often to give rise to an epidemic. The mode of infection in plague is discussed by Dr. Tidswell in the following paragraphs:—

"*Further Observations on the Mode of Infection*," *by Frank Tidswell, M.B., M.Ch., D.P.H., Micro-Biologist to the Board of Health.*

251. The subject of the mode of infection was previously discussed (Report, 1900, Appendix A) under the sub-headings of (*a*) inoculation, (*b*) ingestion, and (*c*) inhalation. It was shown that experimental animals such as rats and guinea-pigs had invariably succumbed to subcutaneous inoculation; and that they sometimes became infected by feeding; whilst the few experiments concerning inhalation had given negative results. Except in the matter of inhalation with which some other investigators have reported successful results, and upon which our own observations are too few to afford valid data, the issue of these experiments was in general accord with similar experiments made elsewhere. Further, they have their counterpart in epidemiological observations. For according to current belief the acquisition of plague by ingestion, if it occur at all, is not epidemiologically operative, whilst inhalation is held to afford the mode of entry only in the pneumonic form of the disease. On the other hand, the outcome of our local experience is in keeping with the general tenor of available reports in ascribing the overwhelming majority of attacks to inoculation of the bacillus of plague through some part of the external surface of the body. Accordingly the questions of infection by inhalation or ingestion have been left in abeyance, and the laboratory observations since made have been directed towards the elucidation of the manner in which the micro-organisms of plague effect their passage through the skin.

(*a*.) *Infection through slight skin lesions.*

252. In the former report it was mentioned that some of our patients showed wounds or abrasions of some part of the skin within the lymph-collecting area of the bubo; but that in all instances in which material from such lesions was examined no plague bacilli were detected in it. On the other hand, attention was directed to facts which showed that plague could be acquired through small wounds of the skin, *e.g.*, the cases of certain medical men in India and China who became infected through wounds incurred whilst making autopsies of plague cadavers. It was reported, by way of experimental support in this matter, that the test animals used in this laboratory had always died after subcutaneous inoculation of cultures or plague infected material, and an instance was given in which death followed so small a lesion as a prick with an infected needle. It may be added that culture material applied to a lightly scarified area of a guinea-pig's skin has been found to be followed by infection.

253. More recently information has come to hand of the observations of Weichselbaum, Albrecht, and Ghon, confirmed by Kolle (Zeitschrift für Hygiene, XXXVI, p. 397), that guinea-pigs succumb to plague after the application of culture material to a shaved area on the abdominal skin. Repetition of this experiment was successful in the three instances in which it was tried in this laboratory, but only on condition that the culture material was applied immediately after shaving. In four other instances, when the animals were allowed to remain twenty-four hours (3) and seventy-two hours (1) after shaving before the application of the culture material, the animals all remained unaffected. The first three animals serve as controls to the last four as regards virulence, for they were inoculated from the same cultures at the same times. Five similar experiments were performed by application of the material to the shaven thigh of guinea-pigs. In three, the application was made immediately after shaving; one died on the fifth day from plague; the other two remained unaffected. In another animal the application was made in twenty-four hours and the animal died on the fourth day; no plague bacilli were found in the tissues and the isolation of *staphylococcus pyogenus aureus* and *staphylococcus pyogenus albus* from the blood, liver, and spleen showed that death was due to ordinary septicæmia. The remaining guinea-pig of this series underwent the application seventy-two hours after shaving and remained unaffected by it. In a third series of animals the application was made to a shaved spot on the head. Of two of them to which the application was made immediately after shaving, one died, the other remained unaffected. Two others receiving

* But, since this was written, naturally-infected specimens of *Mus Rattus* have been found on one premises only.

receiving the application in twenty-four and seventy-two hours respectively after shaving, remained unaffected. The total result of these experiments was that five animals succumbed to the plague; three after application of the material to the abdominal area, and one each after its application to the thigh and head respectively. In all cases these animals received the application immediately after shaving. In the remaining cases where an interval of twenty-four hours or more elapsed between shaving and the application of culture the animals did not die of plague. In all the fatal cases there was evidence of local re-action in the formation of tiny vesicles (*phlyctenules*) upon the infected shaved areas. The essential details of the experiments are given in the following table:—

TABLE XXVI.—Showing the results of application of culture of *bacillus pestis bubonicæ* to shaved areas of guinea-pigs.

No.	Part shaved.	Time culture applied after shaving.	Result.	Remarks.
1	Abdomen	Immediately	Died 3rd day...	Phlyctenule 2nd day; inguinal bubo; P. bacilli in tissues.
2	" ...	" ...	" 8th " ...	" " "
3	" ...	" ...	" 3rd " ...	" " "
4	" ...	24 hours ...	Unaffected.	
5	" ...	24 " ..	"	
6	" ...	24 " ...	"	
7	" ...	72 " ...	"	
8	Thigh ...	Immediately	"	
9	" ...	" .	Died 5th day...	Phlyctenule 3rd day; inguinal bubo; P. bacilli in tissues.
10	" ...	" ...	Unaffected.	
11	" ...	24 hours ...	Died 4th day...	No phlyctenule; no bubo; pyogenic cocci in tissues.
12	" ...	72 " ...	Unaffected.	
13	Head ...	Immediately	Died 10th day..	Phlyctenule 3rd day; cervical bubo; P. bacilli in tissues.
14	" ...	" ...	Unaffected.	
15	" ...	24 hours ..	"	
16	" ...	72 " ...	"	
17	Abdomen	Control ...	Died 5th day...	Subcutaneous injection; inguinal bubo; P. bacilli in tissues.

254. The shaving of the guinea-pigs was performed in the ordinary way after lathering with soap; the shaved area being afterwards washed clean with sterilised water. Antiseptics were not used in view of their presence vitiating the results. One's personal experience of the smarting occasioned by the application of cosmetics (*e.g.*, Bay rum) to the recently-shaven chin and the associated suggestion of denuded epithelium led to the shaved areas of the guinea-pigs being carefully examined with the aid of a hand lens for evidence of minute lesions. No animal showing actual small cuts or oozing points was used in the above experiments. But short of actual penetration of the skin there were usually to be seen small red points—capillaries showing through the partially-removed epithelium—and the whole area presented the appearance of superficial denudation of epithelium. The material on the razor contained an abundance of epithelial cells, and no doubt, from a histological point of view, the amount of epithelium removed would be pretty considerable. It is to be concluded that the shaved skin is not intact: it is rather the site of a mild abrasion. From the results presented above—the lethality of immediate and innocuousness of later applications—it appears that even this slight abrasion causes enough impairment of the protective function of the epidermis to permit, when recent, the passage of bacteria to the deeper tissues, but that in the course of twenty-four hours the injury is sufficiently repaired for such invasion to be successfully resisted. Physiological considerations no less than actual experience suggest that the passage of plague bacilli through the skin is conditioned by the presence of a lesion of the epidermis at least, but the foregoing observations indicate that the necessary lesion may be very minute.

255. Presuming that minute or gross lesions, such as would suffice for the entrance of plague bacilli, are commonly present upon the human skin, there still remains, as an essential factor for infection, the contamination of the lesion by plague bacilli. In exceptional instances the contamination results from actual contact with infected persons or rats, but in the great majority of cases neither of these conditions obtain. For the mode of infection under review to be epidemiologically operative, the bacilli must be capable of extracorporal existence upon such materials as might gain access to the lesion.

(*b*) *Viability of bacillus pestis upon inanimate materials.*

256. The possibility of plague being acquired per medium of soiled articles led to the following observations being made in this laboratory with the object of determining how long the bacilli could survive upon such articles under the climatic conditions met with in this country. The method followed was to infect portions of various materials, remove them from the source of infection, and subsequently ascertain by culture how long the bacilli remained alive in them. The materials were initially sterilised and then infected by soaking them with broth emulsions of agar cultures of bacillus pestis. They were placed upon unglazed porcelain slabs enclosed within double glass dishes. Samples of each were removed at intervals of one or two days and placed in bouillon tubes, then incubated for twenty-four hours, after which subcultivations of the bouillon were made upon agar tubes. The usual bacteriological checks were made of the initial sterility of the articles used and of their subsequent freedom from extraneous contamination, as well as of the identity of the bacteria in the ultimate cultures. Three observations had to be rejected on account of miscarriage of the precautions and contamination at some stage or other, but otherwise no difficulty was experienced in carrying the tedious observations safely through to the end. In view of the fact that many observers have stated that the bacillus is readily killed by drying, the various

various experiments were arranged so as to display the results when the materials were dried rapidly, dried naturally, dried slowly, and kept wet. The first was effected by placing the dishes in the incubator, with a layer of cotton-wool between the upper and lower dishes; the materials all appeared to be dry in about twenty-four hours. The second could not be exactly obtained, since the materials had to be kept in the dishes to avoid contamination, and thus their drying was retarded to some extent; but no special measures were taken to keep them moist, and the materials dried in different periods during the course of a week or two. The third process was effected by placing the porcelain slab on slightly-moistened cotton-wool, which kept the glass chamber moist for a time, and delayed the drying of the materials for two or three weeks. In the fourth case the slab was placed on wet cotton-wool, and the materials did not become dry during the period of observation. With the exception of those incubated, the materials were kept at the temperature of the laboratory and exposed to ordinary light. It is to be noted that the materials received with the bacilli a certain amount of organic material (*bouillon*) which could serve them as pabulum, and such as would be present if the articles had been soiled by infected bodily secretions. The conditions were unnaturally favourable to the survival of the bacilli, in that they protected them from competing saprophytic bacteria. The materials chosen for observation comprised dust from the corners of floors and shelves of dwellings, and from the floor of a produce-store; grain and other produce; clothing materials (linen, cotton, flannel, tweed, &c.), and packing materials such as straw, wood-fibre, and saw-dust. The results of the observations are shown in the following table:—

TABLE XXVII.—Showing results of experiments to ascertain the extracorporal viability of bacillus pestis upon specified materials.

No.	Material.	Number of Observations.	Number of days Bacilli survived in Material.			
			Rapidly dried.	Naturally dried.	Slowly dried.	Kept moist.
1	Dust of dwelling—corners and between flooring boards	6	1	3, 4, 11	21	15
2	„ shelves	1	.....	.....	2	.....
3	Dust of produce store—floor	1	.....	.....	11	.....
4	„ street	6	−1	3, 3, 10	15	13
5	Grain—wheat	6	1	3, 4, 4	7	11
6	„ maize	5	1	3, 4	7	9
7	Potato parings	3	.....	3, 4	11	.....
8	Carrot parings	2	.....	4	15	.....
9	Peameal	5	1	4, 5	7	11
10	Bran	1	.....	.....	15	.....
11	Flannel (old washed material)	3	.....	3, 4	7	.....
12	Silk (old washed material)	3	.....	3	11	7
13	Muslin (new material)	4	−1	3	21	12
14	Cotton (new material)	5	2	4, 5	15	11
15	Linen (old material)	4	1	3, 4	5	.....
16	Jute sacking (old material)	5	2	4, 5	15	10
17	Tweed (old material)	1	.....	.....	15	.....
18	Serge (old material)	2	1	.....	.....	15
19	Straw	4	−1	1, 4	21	.....
20	Wood fibre	5	.....	3, 4, 9	5	7
21	Sawdust	5	1	4, 5, 9	15	.....

257. The fact that the bacilli died out in periods varying from less than one day to three weeks, may be taken as indicating that their extracorporal existence is a matter of survival rather than of continued viability. For, as already stated, the materials were soaked with nutrient broth, such as would have supplied the bacilli with abundant food under the condition of artificial cultivation. The issue of the different series of observations shows that the bacilli are markedly influenced by drying. In materials rapidly dried the bacilli survived usually not longer than 24 hours, sometimes less, rarely more; and never longer than two days. In materials drying naturally the bacilli survived usually three or four days, in a few instances for nine, ten, or eleven days. In material drying slowly they survived usually for one or two weeks, and exceptionally for three weeks. In all these instances their extinction seemed to be associated with the drying of the material, but the data contained in the last column of the Table indicate that excessive moisture is not greatly favourable to their continued existence. These various results are in accord with those previously reported (Report 1900, p. 55), and generally with those reported by other investigators.

258. The chief interest necessarily attaches to the results of those experiments which most closely simulate natural conditions. In so far as those dealing with naturally and slowly dried materials may be regarded as fulfilling these conditions, they indicate that the bacilli may be expected to survive on inanimate materials for three or four days as a rule, and that they can survive for as long as two or three weeks in diffused daylight, and at the ordinary indoor summer temperature in this city. But it has to be remembered that the experimental conditions are in fact more favourable to the bacilli than strictly natural ones would be, so that the indicated survival is probably in excess of that which would obtain in nature. It is accordingly to be inferred that such materials can only serve as the means of disseminating plague for usually not longer than three or four days, but exceptionally for two or three weeks after becoming contaminated with plague bacilli.

259. It does not seem likely in view of these results that the infection was brought to us with merchandise from oversea, nor that the second epidemic arose by redispersal of infection remaining latent after the first epidemic. But they do not in themselves exclude infected articles from having had some

share in the local dissemination of the disease. The survival of the bacilli is long enough, in dust and clothing for example, to admit of their carriage therein to lesions such as those mentioned in the previous section. However, if such articles played a part here they were not contaminated by plague-stricken persons, for our patients most often had no association whatever, direct or indirect, with the sick. The one suggestive common feature in their histories is their association with plague-stricken rats. Perusal of the accounts of the two epidemics that have occurred in this State shows that plague-rats have pre-eminently figured as the associates of plague in man, and in many localities it was clearly manifest that they were the forerunners of the incidence of the disease upon human beings. Our experience does not permit us to doubt that the rats were the sources of infection for our patients. But actual contact with them was exceptional; most usually the evidence went no further than to reveal the presence of plague-rats in the vicinity of the place where the patient became infected. As the implied intermediary between rats and human beings, suspicion might reasonably be attached to materials contaminated by the rats.

260. But given the lesion of the skin referred to in the previous section, and given contaminated material such as that just described, infection yet depends on the accidental conjunction of the two within a limited period of the time the last mentioned has received its load of bacilli from the rat. For this conjunction to occur with sufficient frequency to produce an epidemic of plague implies that the bacilli are distributed broadcast by the rats. But there is no good evidence that plague-rats do so generally infect their surroundings. On the other hand attention has already been called (Report 1900, p. 55) to the fact that rats, guinea-pigs, and mice were often placed by us in intimate contact with their artificially plague-infected fellows, or in the uncleaned cages and jars in which animals had died of plague, without in any single instance becoming infected. More recently we have exposed guinea-pigs with shaved abdomens in similar jars with the same negative results, even when the jar and its contents were additionally contaminated with culture material quickly fatal to inoculated controls. The escape of these very susceptible animals under conditions so favourable for mediate infection from soiled articles makes it difficult to conceive how the chance transference of the bacilli in this manner can be epidemiologically significant. In view of all the circumstances it would appear that whilst this mode of infection is possible, and may be occasionally operative, available evidence falls far short of indicating, or even suggesting, it to be the usual or regular means by which epidemics of plague are maintained.

261. That is a very lucid description of the circumstances which must obtain in order that the infection of plague may be communicated from the rat to man. There must be a breach of that epithelium whose function it is to defend the body against invasion by micro-organisms; the breach must be recent and (probably) not more than twenty-four hours old; the infection must be deposited by the rat on inanimate articles with which man can come into contact (or, rather, epidemiologically speaking, is likely to come into contact), and it must not, as a rule, be more than three or four days old: and then, when these four conditions have coincided a fifth must concur with them, which is, apposition of the wound and the deposited infection. The chances against the required conjunction are evidently many. Slight defects of the epithelium sufficient for the contemplated purpose are, perhaps, not very uncommon, and rats which traverse articles in use by man at the requisite stage of illness can discharge infection upon them (from the nasal mucous membrane in earlier, with the excreta at later, stages); yet it does not require much consideration to see that in practice the infection can rarely be taken thus. But I have already expressed an opinion that among the conditions necessary to the spread of infection from rat to man there must be some one (at all events) which is rarely present in conjunction with the rest; can failure to bring the minute wound into contact with the small quantity of deposited infection be it? Clearly such failure must happen much more often than not.

Twelve Cases in which Infection was not taken, in all Probability, by Casual Contact with Deposited Infection.

262. The infection of plague is communicated to man by inoculation through the skin in the vast majority of cases. The proof has been well stated in the Report of the Plague Commission in India; it is " . . . . that primary buboes practically always develop in connection with lymphatics which originate in the skin . . . . . " The constant preponderance of "inguinal" or "groin" buboes over others, was also shown in the same paper to stand in relation to the larger area of skin which drains through the lymphatic glands of the groin. Analysis of returns, which represented 5,442 cases of bubonic plague, showed that the ratio in which buboes occurred in the lymphatic glands of the head and neck, the axilla, and the groin respectively, was nearly the same as the ratio which the skin-areas draining through the lymphatics of those regions bear to each other.

263. The proportion in which groin buboes are met with always preponderates over that in which the buboes occur in other regions of the body; this was very early observed among Eastern races who habitually go barefoot. Before long, however, the same preponderance was noticed among Europeans (though in small number) who did not go barefoot; but the hint thus given seems to have been overlooked, and (perhaps, in consequence) assumed infectiveness of ground-surfaces became a prominent feature in writings on the ætiology of plague. But at Sydney, in 1900, we were able to show that in no less than 73 per cent. of the 286 cases in which buboes were exhibited, the latter were found in the groin, although all the patients referred to were white, clothed in European fashion, and invariably shod during the day (Report, 1900, p. 40). The validity of the banal explanation of the preponderance of groin buboes thus seemed to be rendered more than doubtful.

264. But I had pointed out in the same Report, that the infection of plague was received by man, for the most part, within houses; which seems also to have been noticed in India (Plague Commission in India, July, 1901, Report, p. 101). Now, if the infection be usually received by man within houses, the objection raised above to the banal explanation of the preponderance of groin buboes must be revised; for there is a time of day when nearly all people, whites as well as others, go barefoot; namely, when they are going to bed or rising from it. At that time, therefore, infectious material deposited on floors, carpets, &c., by rats (or otherwise) would be more likely to come in contact with the unprotected skin of the feet than with that of any other part of the body. So that, although conjunction between a recent breach of the epithelium and deposited infection in the requisite state of activity cannot often happen, here is the opportunity for it at all events; and plague was not so frequently contracted by our people in either epidemic but that possibly those persons who exhibited groin buboes might have received the infection in that way. Let us try, then, to ascertain what the fact was: Does the record contain any cases in which infection resulting in groin buboes was, probably, not contracted by casual contact with deposited infection of the unprotected skin of the lower extremities? If it turn out that it does, the hypothesis under examination will be very greatly weakened; must, indeed, be discarded as an explanation of epidemic bubonic plague.

265. Among the 139 cases which constituted the epidemic, there were 106 in which buboes occurred in the groin. But it is necessary to speak more exactly. Our present concern must be with primary buboes, since these alone indicate the region of skin through which the virus entered; and, in order to leave no room for possible confusion between primary buboes and secondary glandular swellings, it is desirable to take into account only those cases in which the groin bubo was solitary. Then the expression "groin bubo" is loose. A bubo in one of the oblique set of inguinal glands indicates infection through the skin of the lower part of the trunk. Buboes in one of the vertical set of femoral glands alone indicate infection through the skin of the feet, or of other part of the lower extremity. An examination intended to discover whether there were buboes betokening infection through the skin of the lower extremity must, therefore, be limited to cases which exhibited *solitary* buboes in one or other gland of the *femoral* chain.

266. The total number of such cases was 60, but the majority are not available for the present purpose. Thus the place at which the infection was taken could not be determined in 16 of them; either the inquiries made failed to reveal any clue to it, or else the evidence for infection at home and at work seemed equally cogent. These 16 must be thrown out, therefore, for they (or some of them) may have been infected at their place of residence, where they were admittedly exposed to the risk ascribed to bare feet which is now under investigation. In 25 other cases it was considered that the patient did receive the infection at his place of residence; so that these, too, must be thrown out for the reason just given. In 3 others the place of employment probably was the place of infection, but the details left room for some slight doubt; these are excluded by way of precaution. Three more were Chinese, concerning whom either information of the required kind could not be got at all, or it was untrustworthy. Lastly, one was a woman whose movements could not be traced. So that 48 of the 60 have to be discarded.

There

There remain 12 patients who had solitary femoral buboes, and who are confidently adjudged to have received the infection away from home (while at work, in all but one case) and therefore while fully clothed.

267. Most of these twelve cases have been already referred to at greater or less length; their serial numbers are therefore given, together with a reference to the paragraphs in which the necessary particulars concerning them may be found: 1 (par. 77), 14 (par. 92), 18 (par. 212), 211 (par. 21), 34 (par. 217), 49 (par. 134), 70 (par. 218), 84, 88, 93, 125, 129 (par. 219). The following are details of the four cases which have not previously been described:—

Case 84.—M., æt. 39, a tailor; attacked, March 26, at midday, while at work; discharged, May 24; place of employment, 267 Pitt-street. From under the floor of the room in which the patient worked as a presser nine carcases were removed; many others were found under the floors of adjacent rooms, as well as large quantities of rats' dung, nests, rags, paper, and seeds (from a florist's). Place of residence, Strathfield, a suburb 7 miles away, which has harboured no other case of plague at any time; the house was in very good order, and entirely free from all traces of rats.

Case 88.—M., æt. 55, carpenter; attacked, March 27, morning; discharged, April 26; place of employment, Union S.S. Co.'s wharf, Darling Harbour, which was one of the infected line. Residence, Leichhardt, a suburb about 3 miles away, which had yielded no indigenous cases; the house was in good order, clean, and entirely free from all traces of infestation.

Case 93.—F., æt. 27, sempstress; attacked, April 3; discharged, May 21; place of employment, an upholsterer's, 137 to 141 Castlereagh-street. There were abundant signs of infestation with rats everywhere, but no carcases were found; dead rats had been seen six weeks earlier when, it was alleged, poison had been laid. Residence, Marrickville, a suburb about 4 miles away, which had at no time harboured any other case; the house was in good order, and entirely free from all traces of infestation.

Case 125.—M., æt. 54, carman; attacked, May 11, midday; died, May 16; place of employment, Gray's stables, Elizabeth-street, Waterloo, which were infested with rats, and from which a plague rat had been taken on April 26; another plague rat was taken at other stables near by on April 21. Residence, 151 Bullanaming-street, in fair order; it was said that no rats had been seen there, and there were no traces of infestation; no indigenous case had occurred anywhere near the house, but the further neighbourhood of it was not free from suspicion.

268. Of these patients 8 inhabited houses in neighbourhoods which were distant or even remote from the infected area, and which were at all times free from suspicion of infection with plague (yielded neither indigenous cases, nor plague-rats); and while, on the one hand, 11 of the residences bore no traces whatever of infestation with rats (the twelfth alone having exhibited some slight signs of infestation), on the other hand the places at which the patients were employed (including one who had merely visited Her Majesty's Theatre) were badly infested, and had yielded dead rats in number in ten instances at least.

269. It is certain that these persons all fell into danger at their place of employment, and apparent that they were not infected at home. At their employment they were fully clothed; their lower extremities were protected by boots, socks, or stockings, and trousers or petticoats, while their hands, arms, necks, faces, and in some cases their chests too, no doubt, were uncovered, exposed, and in no way protected from casual contact with deposited infection: and, therefore, they should, *ex hypothesi*, have exhibited cervical or axillary buboes. In fact, however, they none of them did so. They were all of them inoculated in one or other lower extremity—in that very area of skin which, beyond all doubt, was well protected from casual contact with deposited infection.

270. I am unable to imagine any plausible explanation of the inoculation of these 12 persons in the lower extremity, which does not include some means of communication between them and plague-rats which is complete in itself, endowed with locomotive powers, attracted to man by instinct, and more likely to reach this than any other part of the body. These requirements betoken an insect, and the insect which best meets them appears to me to be the flea.

Only one other mode of common communication of the infection from rat to man can be surmised, namely, soiling of food with infective excretions or secretions. But the conclusion that bubonic plague is taken by inoculation through the skin is generally accepted on definite pathological evidence; while the other generally-accepted opinion that, at most, man has very rarely been infected by feeding, is based on the all but entire absence of similar pathological evidence to the contrary.

271. Simond's results with fleas have not as yet been corroborated in this laboratory; but several unsuccessful attempts have shown that the experiment is a very difficult one to control, rather than that the infection cannot be conveyed by means

means of fleas. A good deal of time has been devoted to preliminary or collateral points by Dr. Tidswell, whose results and remarks upon them are embodied in the following report :—

Ecto-parasites of the Rat. By Frank Tidswell, M.B., Ch.M., D.P.H., Micro-Biologist to the Board of Health.

(c) *The Ecto-Parasites of Rats.*

272. The failure of available facts to clearly incriminate deposited infection as the source of plague in our patients made it important to investigate another possible intermediary. In the previous report (1900, p. 56), attention was called to Simond's suggestion that the fleas from rats probably played such a part. In connection therewith it was mentioned that the phlyctenules described by Simond as resulting from the bites of plague fleas had been observed in a few cases in which they had been looked for; that plague bacilli had been found in one of them, and had been also obtained from fleas taken from an infected rat (loc. cit. Appendix A, p. 56). During our more recent experience the occurrence of plague bacilli in fleas taken from infected rats has been twice more demonstrated in a similar way, viz., by cultivation and inoculation experiments. This thrice-repeated observation is in accord with the accounts of other investigations elsewhere, and it seems now well established that fleas from plague rats can harbour plague bacilli. Although this is so, it has not yet been adequately demonstrated that the bacilli so harboured can be carried over to other animals to which the affected fleas have access. Simond, indeed, reported successful results, but the similar experiments of Dr. Kolle in Berlin (Zeit. f. Hyg. Bd. 36, s. 412), and those performed in this laboratory (Report, 1900, p. 57) had negative issues. From the experimental point of view, Simond's observation remains hitherto unconfirmed.

273. Objection to the theory has also been made in view of the nature and species of fleas infesting rats. Simond, whilst candidly admitting his inability to pronounce upon the species of the fleas found by him upon rats in India, and to which he attributes the power of transmitting plague, nevertheless distinctly states that the fleas in question did bite human beings on whom they were placed. (Annales de l'Institut Pasteur XII, p. 673.) On the other hand it has been contended that the fleas infesting rats will not bite man. Dr. Nuttall, of Cambridge, points out that the "rat flea"—*Typhlopsylla musculi*—belongs to an entirely different family from the flea of man—*Pulex irritans*—and that there is no evidence that it will use man as a host (Johns Hopkins Hospital Reports, VIII, p. 21; Jl. Trop. Med., V, p. 65), whilst Professor Galli Valerio, of Lausanne, reports similarly with respect to the two species of fleas—*Typhlopsylla musculi* and *Pulex fasciatus*—found by him upon rats in Europe (Cent. f. Bact., XXVII, s. 1; *ibid.*, XXVIII, s. 842; Jl. Trop. Med., V., p. 33). Briefly, it is said on the one hand (Simond) that fleas from rats did bite man, and on the other hand (Galli Valerio), that fleas from rats did not bite man. In view of the simple nature of the fact to be determined, it would appear most likely that the discrepancy is due to the reference being to different species of fleas. For it by no means follows that the rats in India and in Europe are exclusively infested by the same species. Available accounts, indeed, clearly indicate that a species prevalent at a particular place or time may be represented by a different species at another place or time. For instance, Mr. Carl Baker expresses the opinion that *Pulex inaequalis* seems to be the North American representative of *Pulex goniocephalus* of European hares and rabbits (Canadian Entomologist, XXVII, p. 164), and Mr. L. O. Howard reports that the species which commonly overruns houses during damp summers in the Eastern cities of America "is not, as many have supposed, the human flea,—*Pulex irritans*—but the common cosmopolitan flea of the dog and cat"—*Pulex serraticeps*—(Bulletin No. 4, Division of Entomology, U.S. Department of Agriculture, 1896, p. 24). Further, it is mentioned in the report of the outbreak of plague at Sydney, 1900 (p. 40), that *Pulex serraticeps*, a species known to attack man, was found upon the rats examined during that epidemic. This last occurrence is not noted in any other document available to me, and Professor Galli Valerio's comment upon it is that it must be so rare as to be accidental. However this may be, it is clear from the items just quoted that there is need for inquiry as to whether the prevalent species in Europe are also the prevalent species elsewhere. For unless this be shown to be the case statements concerning the habits of *Typhlopsylla musculi* and *Pulex faciatus* are insufficient to negative the idea of the participation of a flea of some kind in the dissemination of plague.

274. In pursuing our investigation of Simond's theory it seemed desirable, in view of what has been said above, to ascertain in the first place the exact species of fleas to be found upon our rats. The opportunity afforded by the receipt of rats for the pathological and bacteriological examinations already described was accordingly made use of to secure specimens of fleas upon them. It usually happened that the carcases of the rats were brought to us wrapped up in paper parcels. To facilitate collection of the fleas, as well as a precautionary measure of protection against possible danger from them, it was made a rule to pour a little chloroform through a small hole in the paper before the parcel was opened. This sufficed to stupefy or kill the fleas, which were then picked up from the paper or obtained from the fur by searching with the aid of a fine-toothed comb. This process was carried out during the height of the epidemic until about 100 specimens were collected; this number being deemed adequate to afford a reliable representation of the species present. The fleas obtained were immediately placed in Xylol and afterwards mounted in Canada balsam for microscopical examination. In classifying the species I have been mainly guided by Mr. Carl Baker's descriptive list (Canadian Entomologist, V. 27), but access was also had to Taschenberg's "Die Flohe," to Neumann's "Traité des Maladies Parasitaires," and to other works of a similar character. I have also to gratefully acknowledge assistance afforded to me by Professor W. A. Haswell, F.R.S., Sydney University, and by Mr. W. G. Rainbow, F.L.S., Entomologist to the Australian Museum, Sydney, who were good enough to examine my specimens and check my determination of species.

275. The initial position of affairs, so far as one could gather it from available documents, was that one might expect to find on the rats two species of fleas—*Typhlopsylla musculi* and *Pulex fasciatus*—and there was a suggestion that at least one other species—*Pulex serraticeps*—might also be found upon them. Actual examination of the specimens collected as above described showed, however, that no less than four species were represented. In accordance with the statements of European and American observers two of the species were *Typhlopsylla musculi* and *Pulex fasciatus*. In confirmation of our previous report

report the third species was *Pulex serraticeps*. But the fourth species was one not hitherto mentioned as occurring on ordinary rats. A photograph of this flea (as well as of the other species found) is given in the plates herewith. After long and minute examination I concluded the flea was *Pulex pallidus*, or else was an undescribed very close ally of that species. In this conclusion Mr. Rainbow agrees, as also does Professor Haswell, although the latter points out some minor differences from Mr. Baker's description of the type. I have, therefore, felt justified in referring to the flea as *Pulex pallidus*, at all events provisionally and for the purposes of this report. Mr. Baker states that *Pulex pallidus* has been found on *Mus albipes* (the Abyssinian white-footed rat) in the island of Socotra, and upon *Herpestes ichneumon* (Pharoah's rat) in Egypt, so that its being found here upon a species of rats would be consonant with its already known habits. It is more particularly interesting in being a very near relative of the flea of man—*Pulex irritans*—from which it differs in general size and colour it is true, but otherwise only in details such as the comparative lengths of the tarsal joints, number of joints in labial palpi, and conformation of male generative organs.

276. The species referred to, and henceforward in this report called *Pulex pallidus*, not only occurred on the rats, but was by far the most abundent species present. Of the 100 specimens collected and examined as above-mentioned, 10 were identified as *Pulex fasciatus*, 8 as *Typhlopsylla musculi*, 1 as *Pulex serraticeps*, and no less than 81 as *Pulex pallidus*. The overwhelming percentage of the last-named species removes its occurrence from the sphere of accident; there can be no question that at the time the observations were made it was the prevailing species of flea infesting the rats.

277. In order to determine whether this occurrence of *Pulex pallidus* was a purely local circumstance, or applied also to other parts of Australasia, I addressed a request for specimens to official confreres in the other States of the Commonwealth and New Zealand. I have here to thank Dr. Burnett Ham, of Queensland; Dr. Astley Gresswell, of Victoria; Dr. T. Borthwick, of South Australia; Dr. Blackburne, of West Australia; and Dr. Mason, of New Zealand, for their generous efforts in response. I append hereto a tabular statement of the species found amongst the specimens so kindly forwarded, except as regards those from Victoria which arrived in too mummified a condition for accurate observation. By way of completion I have inserted the figures for Sydney, and those for the fleas forwarded from Newcastle in this State by my colleague, the Medical Officer of Health of the district, Dr. Robert Dick.

TABLE XXVIII.—Showing Numbers and Species of Fleas obtained from different parts of Australasia.

Locality.	No. of Specimens.	*Typhlopsylla Musculi.*	*Pulex Fasciatus.*	*Pulex Serraticeps.*	*Pulex Pallidus.*
Brisbane, Queensland	103	18	.....	6	79
Adelaide, South Australia	1	.....	.....	.....	.....
Perth, Western Australia...	6	5	.....	.....	1
New Zealand	56	3	53	.....	.....
Newcastle, New South Wales	34	24	3	.....	7
Sydney, „	100	8	10	1	81
Totals	300	58	66	7	169

278. It will be seen from the table that *Pulex pallidus* was found amongst the specimens from every place except New Zealand. The fact of its presence in Brisbane, Newcastle, Sydney, Adelaide, and Perth, justifies the inference of its general distribution along the east, south, and west coasts of Australia, for it is probably to be found also in Melbourne. As no response was made to my letter to Tasmania, I have no data with respect to that island.

279. *Pulex fasciatus* comes next in point of numbers, but was found in three only of the places mentioned.

280. Specimens of *Typhlopsylla musculi* were nearly as numerous as *Pulex fasciatus*, and were more generally distributed, being actually present in all but one, and probably to be found in all the places mentioned.

281. Least numerous were specimens of *Pulex serraticeps*, which were found only amongst those collected at Sydney and Brisbane. It may be mentioned, however, that some of the dried fleas forwarded from Melbourne appeared to belong to this species.

282. It will be seen from these observations that the ordinary fleas of rats—*Typhlopsylla musculi* and *Pulex fasciatus*—noted by European and American authorities, are well represented upon the rats in this part of the world; that another species, here called *Pulex pallidus*, and not noted by the authorities mentioned, is even more common upon the rats of the Australian continent, and that *Pulex serraticeps* is to be found upon our rats in some instances. Whether or not the number of the latter is so small as to be validly attributable to accident may be left an open question. It is at least certain that *Typhlopsylla musculi* and *Pulex fasciatus* are not the only species of fleas to be found upon rats; consequently inferences based upon observation of them alone cannot be accepted as valid evidence in refutation of Simond's suggestion.

283. By way of corollary to the examination of fleas from rats a similar collection was made of fleas from man. Of 101 specimens thus obtained, 85 were *Pulex irritans* and 16 were *Pulex serraticeps*. It may here be added that a single flea obtained from a wallaby during the prevalence of plague at the Zoological Gardens was a *Pulex serraticeps*, and that numerous specimens obtained from dogs and cats all belonged to this species.

284. As regards the capability of attacking human beings, we have but few observations to report. It happened that whereas during the prevalence of plague, we had no particular difficulty in collecting the 100 specimens mentioned above, yet since the disappearance of the epizoötic the rats examined have

have been remarkably free from fleas. Our frequent searches for specimens have been most usually fruitless. It was only now and then that we came across two or three fleas on some particular rat. These rare specimens were either *Typhlopsylla musculi*, *Pulex fasciatus*, or *Pulex pallidus*. Our observations upon their ability to bite us were made during this period of scarcity, so that we were not able to make extensive trials. Our experience as far as it has gone is in accord with the statement that *Typhlopsylla musculi* will not bite man, but we have been bitten by all three pulices. A specimen of *Pulex fasciatus* which bit one of my assistants was afterwards seen by microscopical examination to have its stomach full of fresh (bright red) blood. In some trials with specimens of *pallidus* immediately after they were taken from rats the parasites refused to bite, but a flea of this species bit me readily enough after being kept without food in a glass phial for about four hours. The sensation of the bite, the subsequent wheal, and the presence of bright red blood in the stomach furnished convincing evidence of the parasite's attack upon me. This experience was subsequently repeated upon other persons with like result. As to *Pulex serraticeps*, authorities are agreed that it will bite man, and this is also vouched for by common experience of fleas from dogs and cats.

It will be seen that although we cannot claim to be in a position to make any general statement with respect to the proclivities of the various fleas, the few trials we have made show clearly enough that of the four species found by us upon rats, three—*Pulex pallidus*, *Pulex fasciatus*, and *Pulex serraticeps*—possess the ability to bite human beings. The fact that they could do so as a matter of laboratory observation does not necessarily imply that they would also attack men under more natural conditions; but this does not seem to be an unlikely event, especially if the circumstances be such as to deprive the fleas of ready access to their accustomed pabulum, as must be considered to happen at times in the course of an epizoötic of plague. Upon more than one occasion the officers of this Department in charge of cleansing gangs have reported that the men have been invaded by hordes of fleas when dealing with places at which rats had recently died in large numbers. On two occasions we had the opportunity of verifying the fact that men had been abundantly bitten by fleas, but we did not succeed in obtaining specimens from the men nor from the places concerned. Hence we cannot pronounce as to the species of fleas responsible. In view of the fact that *Pulex pallidus* was the only species occurring abundantly on the rats it naturally falls under suspicion; but there is no certainty that the invading fleas came from the rats, for it is to be remembered that *Pulex irritans* sometimes swarms about habitations. It might be expected that if such fleas came from the rats and could carry plague bacilli with them, the fact would be indicated by some incidence of the disease upon members of the cleansing gangs. It actually happened that six of these men, as well as two rat-catchers associated with them, in all eight persons, became infected with plague. Consequently, although we cannot definitely assert that the fleas commonly infesting rats will of their own accord attack man, there are no data within our knowledge opposed to this eventuality.

The foregoing statements suffice to show that one species of flea—*Pulex serraticeps*—exhibits considerable catholicity in the matter of a host. Mr. Baker mentions various animals upon which it has been found (loc. cit., p. 164), and we have here taken it from cats, dogs, rats, human beings, and a wallaby. In view of the fact that it occurs on both rats and man, it would not be unreasonable to infer that to it, if to any flea, might be attached the suspicion of disseminating plague in accordance with Simond's theory. In this connection it is interesting to note that in Simond's successful transference experiment the fleas concerned are said to have been obtained from a cat. Presumably they or some of them were *serraticeps*. However, two experiments after Simond's plan made in this laboratory with the object of ascertaining if this particular species could act as a carrier of plague from rat to rat yielded negative results.

In the three instances in which plague bacilli were found by us in fleas from plague-stricken rats the species of flea concerned was always *Pulex pallidus*. We are not in a position to state whether or not the bacilli occur in other species of fleas, since we made no systematic observations to determine this point. The circumstance that they were found in *pallidus*, combined with the fact that this species was so abundantly present upon the rats during the epizoötic, brings this flea also under suspicion as a possible transmitter of plague. Although, as already stated, it was ascertained to bite man when hungry, no representatives of the species were found amongst the carefully-searched collection of fleas from human beings. This collection was indeed made after the disappearance of plague from this city—at a period when the rats themselves were almost entirely free from fleas, and so is scarcely adequate to conclusively determine the occurrence or non-occurrence of *pallidus* on man in relation to the question under review. We have been unable to perform any transmission experiments with *Pulex pallidus*. As already stated, the supply of them unexpectedly ran short just at the time when the pressure of work occasioned by the epidemic began to relax sufficiently to enable us to undertake experimental researches. Under the circumstances this flea remains for us merely an object of suspicion to be further investigated if the opportunity presents itself.

With respect to the two remaining species—*Typhlopsylla musculi* and *Pulex fasciatus*—there is nothing to add to what has been said above. For the reason already given, we have not been able to collect them in sufficient numbers for experiment.

The two experiments with *Pulex serraticeps* mentioned above, as well as the two others recorded in the previous report (1900, p. 57), all failed to secure the transmission of plague from infected to healthy rats by means of living fleas. The method we adopted was as follows:—A rat was placed in each of two small wire cages, which were in turn enclosed, with about 4 inches of space between them, within a galvanized iron box. One of the two rats was inoculated subcutaneously with bacilli pestis, and in the course of a day or so, when the animal became sick, a number of fleas was placed upon it. Always the inoculated rat died in the usual time, presented the usual *post-mortem* appearances, and was proved to have died of plague by the usual bacteriological procedures. But always also the companion uninoculated rat remained free from plague. In two instances this survival was shown not to be due to immunity since the rats concerned subsequently succumbed to inoculation with bacilli *pestis*. In the other two instances the companion rats died in one and three days after their respective inoculated associates, but their deaths were not due to plague. The *post-mortem* appearances were not those of plague, nor were bacilli *pestis* seen in smear preparations or obtained in cultures from the blood and viscera. In one of them the blood was teeming with *Trypanosoma*, but beyond this there were no definite indications of the cause of death in either case. It has been our experience that the particular

particular species of rat (*Mus decumanus*) made use of does not generally survive long in captivity. Thus, although two of the rats died in a suggestive manner, it could not be ascertained that they died from plague.

290. The method just described was initially adopted as approximating to that by which Simond obtained success; but a close scrutiny of details reveals it as one very apt to miscarry. For example, in the two experiments more recently performed, the inoculated rats received respectively ten and six specimens of *Pulex serraticeps* obtained from a dog. These fleas promptly disappeared in the fur of the rats, and there our cognisance of them ended. For after death the carcase of the first rat furnished no fleas, and that of the second gave us two specimens of *Pulex fasciatus*. Both carcases had been left untouched for twenty-four hours after death. The carcases of the companion rats being duly searched immediately after their deaths in twenty-four hours and three days respectively after their inoculated associates, yielded, the one a single specimen of *Pulex serraticeps*, and the other, no fleas at all. In the cages we found three specimens of *Pulex pallidus*. After the experiment then we collected 6 fleas, 2 *fasciatus*, 1 *serraticeps*, and 2 *pallidus*—none of which harboured bacilli *pestis*; for smear preparations and cultures from them were all negative. It may be that the single *serraticeps* was one of the sixteen previously placed on the inoculated rats, but this is not certain, and in any case the fate of the other fifteen is not accounted for. It is evident that the method afforded no guarantee that the fleas used actually passed from rat to rat. Some further observations were made by a more hopeful process, kindly suggested to me by Dr. J. S. C. Elkington as having been successfully applied in India by himself and Captain Liston, I.M.S. In this the fleas were retained in test tubes, covered with muslin or chiffon, through which they could bite but not escape. On three occasions fleas were allowed in this way to bite guinea-pigs, sick after inoculation with plague cultures, and, subsequently, to bite other healthy guinea-pigs. The three inoculated guinea-pigs died in the usual time, and presented the usual *post-mortem* appearances of plague, their viscera yielding bacilli *pestis* in abundance. The five associated guinea-pigs also died in periods varying from two to eight days after being bitten by the fleas, but it could not be demonstrated that their deaths were due to plague. In only one instance were the *post-mortem* appearances suggestive of this disease, and from this case a bacillus was isolated, which had, at first sight, considerable resemblance to bacillus *pestis*, but by subsequent investigation was proved not to be that micro-organism. In three of the other animals micrococci only were isolated, and in the remaining one the smear preparations and cultures were all negative. It has to be noted that cultures of blood, taken from the inoculated animals at the time they were bitten by the fleas, yielded bacilli *pestis* in only one of the three, so that there was room for failure in the other two cases. The significant fact of the death of these five animals is not, to my mind, adequately accounted for by the results obtained, and I purpose entering in the near future upon some further experiments with this method. In the meantime, I infer that, although the results obtained by us with respect to the experimental transmission of plague by fleas have as yet been negative, they are properly to be regarded only as inconclusive.

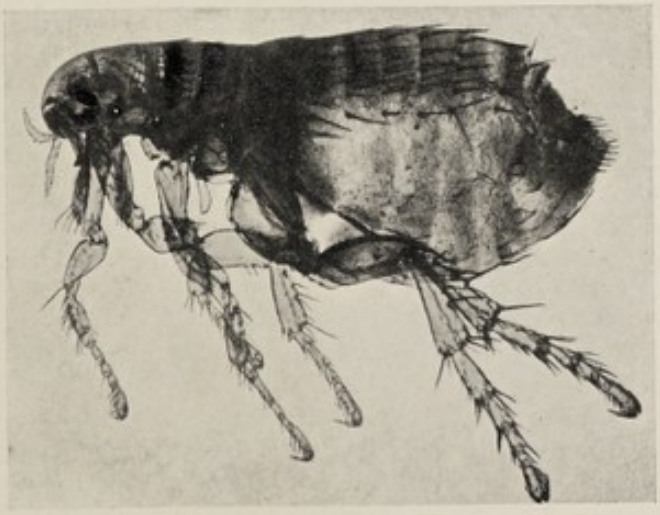
291. Making due allowance for the considerations just presented it will be apparent that whilst the observations made in this laboratory do not furnish convincing proof of the participation of a flea in the dissemination of plague, they are nevertheless all consistent with that hypothesis. We have found that rats coming under our notice during the prevalence of plague harboured more fleas than did those examined after the subsidence of the epizoötic. The fleas collected from them represented four species, of which one—*Pulex serraticeps*—is known to attack man, whilst two others—*Pulex pallidus* and *Pulex fasciatus*—have been ascertained to be capable of doing so. Specimens of one of these species—*Pulex pallidus*—have been three times found to harbour plague bacilli, which produced plague in animals, into which they were inoculated, and were, therefore, virulent. We have also (v. Report 1900, p. 56) found plague bacilli in a phlyctenule, such as has been said to be produced by the bites of infected fleas. Against these various items of positive evidence we have opposed only the results of the transmission experiments which we may not yet consider of final import.

292. It may here be mentioned that the rats were found to be richly infested with bugs. These were in various stages of development, but comparatively few of them were adults. Reference to the authorities of the Australian Museum elicited the information that the species was *Cimex lectuaris*. These parasites continued to occur on the rats after the subsidence of the epizoötic, and are now apparently as numerous as ever. No experimental observations have yet been made with them.

293. A preliminary objection to the hypothesis that plague might be conveyed to man by fleas which had previously bitten rats infected with the disease, has been raised by Nuttall, and by Galli-Valerio; it is, that "rat-fleas" do not bite man. The species of fleas thus referred to by those writers were *Typhlopsylla musculi* and *P. fasciatus*; and these appear to be the species which most commonly infest rats, in some parts of Europe, at all events. The observations now recorded by Dr. Tidswell expose the crudity of this criticism. In the first place, as to the species of fleas which infest rats, he found that, although he was able to collect both *Typhlopsylla musculi* and *P. fasciatus* (Baker), another species, namely, *P. pallidus*, was far commoner on the rats of the Australian coast-line. Here, it may be noted, that Dr. Tidswell first indicated *P. pallidus* as a species commonly infesting rats, an observation which was found to hold good of the rats at Bombay after he had communicated it to correspondents in that city. But, further, the concluding sentence of the abstract paper by MM. Raymond and Gauthier, which is inserted in translation below, furnishes some reason for supposing that the same species might be found on rats in some parts of Europe. And then, secondly, as regards the capacity of the species collected to bite man, Dr. Tidswell tells us that both *P. pallidus* and *P. fasciatus* have done so repeatedly at his hands; it further appears that

(a)

(b)



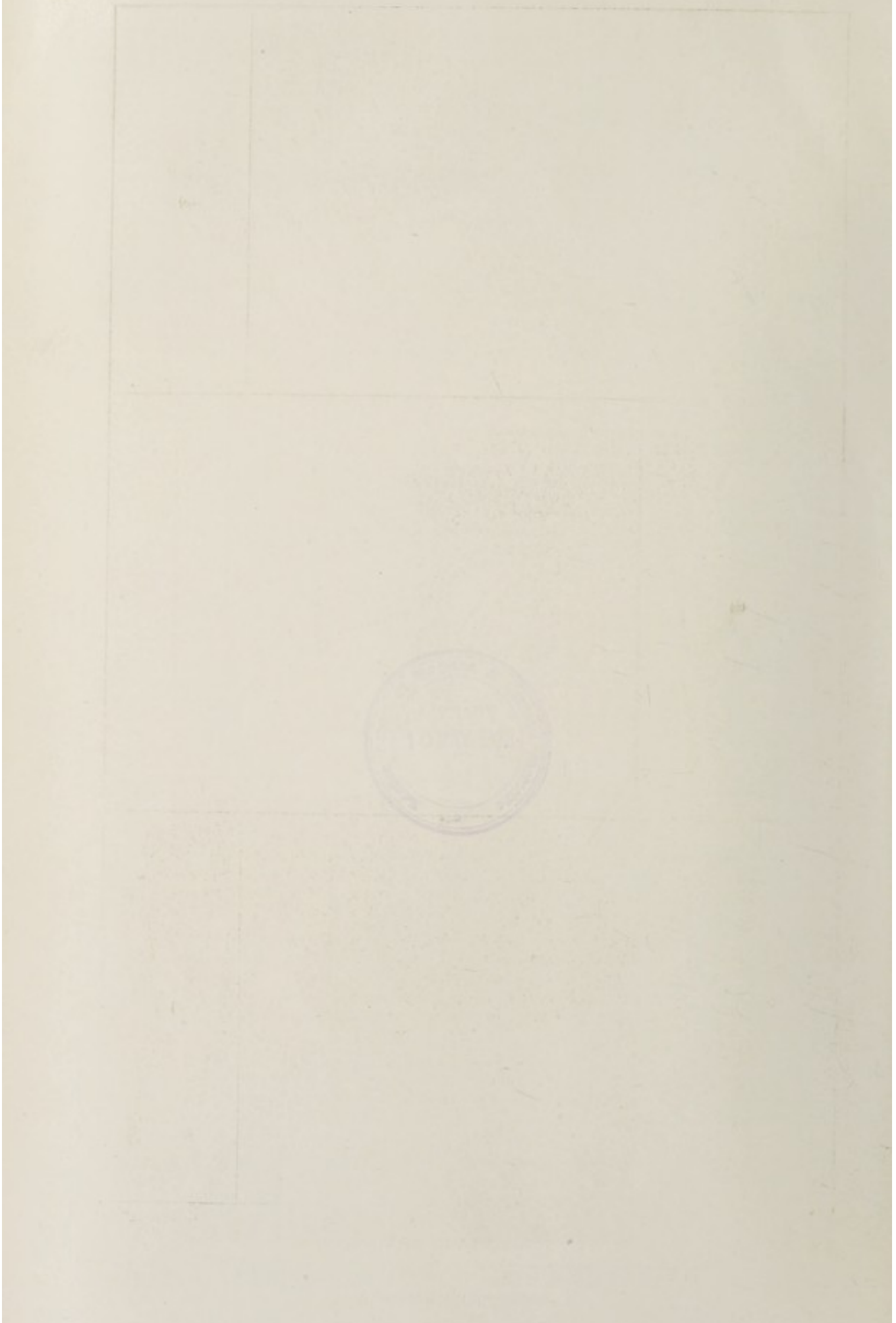
(c)

×c 250

Frank Tolansell.

PHOTOMICROGRAPHS OF FLEAS.

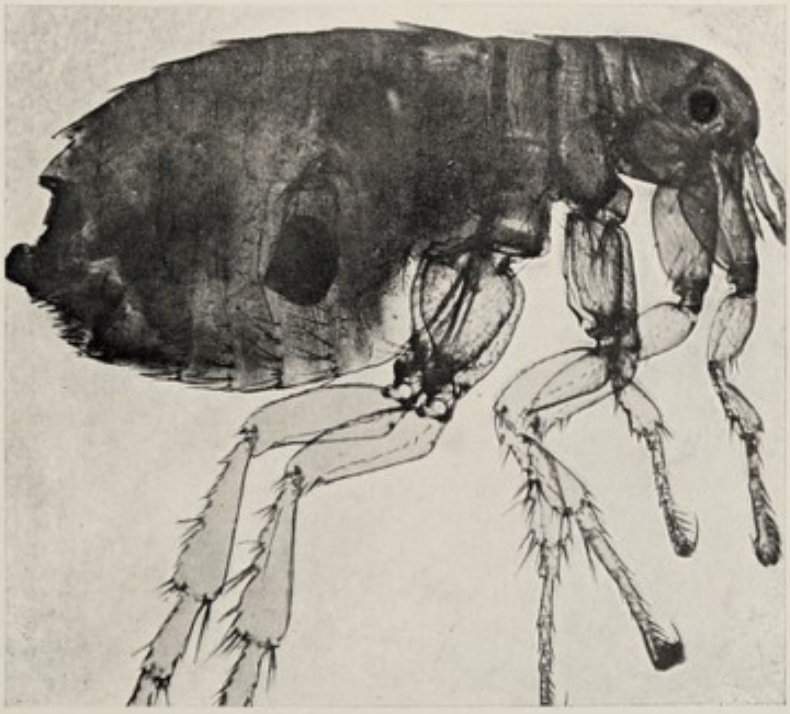
(a) PULEX FASCIATUS, FROM RAT. (b) TYPHLOPSYLLA MUSCULI, FROM RAT.
(c) PULEX SERRATICEPS, FROM RAT.



(d)

(e)

(f)



X² 250

Frank Tidswell.

PHOTOMICROGRAPHS OF FLEAS.

(d) PULEX PALLIDUS, F., FROM RAT. (e) PULEX PALLIDUS, M., FROM RAT.

(f) PULEX IRRITANS, FROM MAN.

that the condition which determined them to bite man was nothing more recondite than hunger. MM. Raymond and Gauthier also found that *P. fasciatus* and *P. pallidus* would bite man. It must, therefore, be considered that the preliminary objection raised by Nuttall, and by Galli-Valerio, has been met; "rat-fleas"—to use the loose phrase employed by those writers for the last time—will bite man. It is probable that *P. pallidus* and *P. fasciatus* do not infest man, and it may be conceded that they do not very eagerly feed on him; the rat, no doubt, is their host of election, although it is plain that they have no repugnance to man. And it appears to me that the phenomena of epidemic plague, as observed at Sydney, require that the intermediary between rat and man should be more usually restrained from acting as such, than encouraged by its instincts to do so. However that may be (for the reader will doubtless reflect that there are other conditions which may act in the same direction of restraint, though by other means) we have here one possible reason why the vicinity of plague-rats is more often harmless to man than it is a cause of plague in him.

294. A further objection has been also raised by Nuttall; it was based on the rapidity with which the bacilli of several diseases, among which plague was not included, lost their virulence after entering the stomach of the flea; this was the result of a long series of experiments performed by him, in which he caused fleas to bite animals previously infected with anthrax, chicken-cholera, and some other diseases. His argument, it will be observed, was from analogy; it now seems to have been met by direct observation. In the first place, MM. Raymond and Gauthier, working at Marseilles, performed many experiments in the transmission of plague from animal to animal, by means of fleas, during the latter half of 1902, and, in December of that year, published the following note, which, on account of its great interest, I take the liberty of translating below:—

"We have undertaken some researches with a view to test Simond's theory of the share taken by the parasites of the rat in the spread of plague.

"In five experiments we have succeeded in transmitting the plague-septicæmia of an inoculated animal to a healthy animal by placing on the former fleas gathered on shore or ship-rats, and by afterwards exposing the healthy animal to the bites of the insects which had been thus infected.

"On the other hand, we did not succeed in effecting a similar transmission by means of the little acari which rats very often carry, nor by the simple cohabitation of healthy with infected animals.

"We then enquired whether the rat-flea would bite man: 14 insects out of 16 bit at once when they were placed on the human skin after having been kept fasting for twenty-four hours. A few fleas survived for many weeks, having been fed exclusively on man.

"Among the rat-fleas which bit man we were able to examine and determine 8; of these 7 were *P. fasciatus*, the kind most commonly found on rats, while the eighth was a kind of flea which had no comb, very like *P. irritans*, but smaller and paler."*

At a later date the authors published their paper *in extenso*.† From the latter it appears that they placed an infected rat in one compartment of a wire cage, and supplied fleas, collected from ship and from shore rats, to it shortly before its death. They then introduced a clean rat into the other compartment, which was separated from the first by an interval protected by a double grating, which was fine enough to prevent the passage of anything slightly larger than a flea, the interval between the two gratings having been about 2 cm. The whole was enclosed in a ventilated glass vessel, specially constructed so as to allow of access to the interior at the same time that the fleas were securely confined to it. It has been shown, again and again, that plague is not communicated from animal to animal when the healthy are put into cages which contain the body of a rat dead of plague, or when the healthy are placed in cages in which plague-rats have died, so that it may be taken that unless the disease was conveyed by the fleas, the healthy rats would have remained uninfected; but although, in addition, the compartments were so separated that the clean rat could not have reached the body of its previously-deceased companion, the result of these experiments was, it will be noticed, inferential as regards the mode in which the clean rat received its infection. This objection, which had been raised against the successful, though meagre, experiments devised and reported originally by Simond, which were arranged somewhat similarly, has been obviated in the method followed by Dr. J. S. C. Elkington, at Bombay,‡ working under Haffkine in the Plague Research Laboratory. The infected and the clean animals were never within reach

* Comptes Rendues de la Société de Biologie, LIV, p. 1,497, December, 1902.
† *Revue d'Hygiène*, XXV, p. 426, May, 1903.
‡ *Australasian Medical Gazette*, XXII, p. 348.

reach of each other. All communication between them, both direct and indirect, was prevented, except that which was the subject of investigation. The fleas were under control, and were placed, first on the infected, then on the clean animal. The clean animals are reported to have died of plague, which can only have been communicated to them by the fleas.

295. We have now reached the end of this study of epidemic plague. The conclusions to which it points differ fundamentally from those which are supported in the most recent writings on the aetiology of this disease. No attempt has been made to explain the discrepancies thus brought to light. I have described what we have seen. It is possible that different circumstances, obtaining in other parts of the world, may account for them in some minor respects; such are the comparative magnitude of epidemics, and their longer continuance elsewhere often witnessed. But as regards more general and (aetiologically) more important features, it is difficult to show that they have been modified by circumstances; unless, indeed, the larger proportion of persons dying at home (who, therefore, had bacilli in the peripheral circulation while they were still exposed to the bites of parasites) may have had some influence. On the other hand, the opportunity of making accurate epidemiological observations has often been denied elsewhere by the character and density of the populations among which epidemics have, for the most part, hitherto occurred. For this reason I am inclined to lay stress on our records; and when, after experience of two separate outbreaks, I am able to say that, with us, the disease was in no degree assisted to assume the epidemic form by direct or indirect communication with the sick, and that place-infection, in the Indian sense, did not exist, it becomes probable that the leading part invariably assigned to these factors by writers who have either worked under the unfavourable conditions adverted to, or who have had no practical experience with epidemic plague, as the case may be, requires revision.

296. As for ourselves, we were manifestly compelled to search elsewhere for a competent cause of the epidemics we had witnessed. We first looked for a source of the infection; we were able to find it, and even to surmise its presence, only in the bodies of diseased rats. We then examined into the distribution of cases in relation to the distribution of plague-rats, and we found that there was a singularly close correspondence between the two, both in time and in place. We noticed, again and again, the establishment of new centres of infection at distant and widely separated points, to which fodder had been transported from a line of wharves already known to be infested with plague-rats; and we remarked precedence of the disease in rats over its occurrence in man at those localised centres. But we also observed that on attempting to ascertain a more direct and closer connection between individual cases of plague and presence of plague-rats on the premises which yielded them, we succeeded only rather more often than we failed; although we learned at the same time that the considerable proportion of failures was merely incidental, in all probability, to the search conditions.

297. Nevertheless we met with many individual cases which seemed to throw great doubt on the efficiency of plague-rats as the cause of epidemic plague. We perceived that although neighbourhood of the latter seemed to be necessary to infection of man, contact with them was certainly not necessary; and, which is even more striking, we learned on irrefragible evidence that presence of plague-rats in a building was very often not accompanied by plague in any of the persons who inhabited it. Further, we found that when the presence of plague (or of dead) rats was accompanied by plague in man, by far the most commonly one person alone out of several composing the household was attacked. On the other hand, we often saw several cases arise at the same time among parties of people between whom the sole bond was daily resort to the same places of employment; and while those places of employment were ascertained to have harboured plague-rats, or at all events rats which had died of some epizoötic disease at a time when plague was known to be prevalent among their congeners in the immediate neighbourhood, it was also ascertained that the infected individuals among those who composed the several groups had, each of them, their dwellings in different houses, situated in widely separated neighbourhoods: which dwellings and neighbourhoods furnished no evidence of presence of the infection.

298. These observations, correct as they had been shown to be by repetition, were puzzling in as far as apparent absence of the only recognisable source of the infection did not betoken safety from plague, and in as far as its ascertained presence

was

was far from being invariably, or even commonly, attended with plague. In this doubt the pathology of the disease came to be reconsidered, in hope that it might furnish some hint pointing to a rational explanation of these apparent contradictions. We recognised the obvious possibility, little likely to be detected by common observation if it were realised, that food might be soiled by passing plague-rats, arrived, perhaps, from premises which they infested, at premises which showed no signs of infestation, but yet yielded cases of plague in man. But this hypothesis it was necessary to dismiss, because there is practically no pathological evidence that man is infected by feeding. If he can be thus infected, it is certain that he is so very rarely indeed; and in that way epidemic plague cannot be explained. On the other hand, the pathological evidence that man is usually infected by inoculation is abundant, uniform, and direct. We considered, then, whether man might commonly become infected by casual contact with virus deposited by plague-rats; for we know that it can be thus deposited, and is likely to be dropped in situations where it may afterwards come into contact with his skin. Thereupon we reflected that a function of the epithelium is to prevent the entrance of infections to the body by way of the skin, and perceived that if this mode is to take effect it can do so only when deposited infection is brought into apposition with a broken epithelium. This, it may be assumed, sometimes has happened; but what is being sought is not an exceptional mode of infection, but one which takes effect so commonly that it may be accepted as a cause of epidemic plague. When, therefore, the very short time is remembered during which such small wounds remain open as alone are in question (because the finding of wounds which might have served as points of entry for the virus in cases of bubonic plague was, in our experience, quite unusual); when the comparatively short, though much longer time, during which the virus survives in potentially active form, even under the carefully guarded conditions of a laboratory experiment is considered—a time which probably must be abridged under the conditions of daily life; and when it is noticed how small must be the parts of the ground-surfaces, &c., which can be thus infected, and, consequently, how great are the chances against the minute wound being brought into contact with them within the requisite times, it becomes apparent that the casual inoculation of man in that way is very unlikely to happen often enough to account for epidemics of plague. It is evident that the means by which he is inoculated must operate more directly and certainly than that. The riddle being still unread, we turned again to our epidemiological notes, and re-examined them. We found, without any difficulty, at least twelve out of the 139 cases in which inoculation could not have resulted from casual contact with deposited infection. They showed that in all probability it must have been effected by some agent, to which neither an unbroken epithelium nor protective clothes offered any important obstacle. But obstacles to chance inoculation both of them certainly are. We were unavoidably compelled, therefore, to contemplate an agent of inoculation possessed of means of evading or of overcoming them. In order to evade protective clothes this agent must be endowed with locomotive powers, and it must be capable of penetrating the epithelium without causing either noticeable pain or a visible wound. It is perceived, of course, that the flea best answers to these requirements.

299. As soon as this has been recognised, it also appears that the original hypothesis of the flea, taken in conjunction with recent observations on the habits of this insect, is exactly what is required to reconcile the apparent contradictions described above; to explain, not merely the erratic incidence of plague, but also the absence of any great probability of the infection being received by man from plague-rats when they are present on inhabited or frequented premises. For we know that the flea which most commonly infests the human race is of one species, while the fleas which infest other sorts of animals are different from it and (as regards several species) from each other; whence it seems evident, *a priori*, that species so usually associated with this or that sort of animal as to be found with certainty upon it when they are searched for, probably have a predilection for their peculiar hosts. On putting this probability to the test of experience, it is found to be so far well-founded that the species of fleas which infest rats seem, on the one hand, not to infest man, but, on the other, to have no repugnance to him. They will feed freely upon his blood if they be hungry. Hence it is plain that there are at least two chances against man's being bitten by any of the species which infest rats. One is that fleas which have left a plague-rat may never come within

reach

reach of man though on the same premises with him; the other is that, if they reach him, they may do so at a time when they are not so urged by hunger as to bite an unaccustomed host. These chances amply suffice to account for the frequency with which all the persons who inhabit premises which are known to have been visited by plague-rats escape, as well as for the rarity with which more than one person is attacked among a household which consists of many, all of whom are susceptible, and all of whom appear—but only appear—to have been equally exposed to danger.

300. Thus, I have been led to conclude that Simond's hypothesis of the flea best explains the phenomena of epidemic plague as seen at Sydney; not, be it noted, by considerations based on his original assertion that plague could be communicated from animal to animal by fleas, but *a posteriori*—that is to say, by observation of the field-facts, as they may be called, and by inference from the records made day by day after they had been collated and duly weighed. And here I would point out a matter which has been overlooked by those who have unreservedly accepted the hypothesis of the flea before it had been sufficiently tested either in the field or in the laboratory. It is that, after it had been shown that plague could be transmitted by these parasites, the proof that *epidemic* plague was thus caused would still remain to be sought, and could be furnished only by an epidemiological study of the field-facts. It is towards this that I am now able, I submit, to offer a contribution. All that is required to support the conclusion drawn is the laboratory proof that this mode of diffusion of the infection is possible. And this, also, seems now to have been given, not merely by MM. Raymond and Gauthier at Marseilles, but also by Dr. Elkington at Bombay, whose observations are confirmatory of Simond's original experiments made in India as much as five years ago. There are points which still remain to be elucidated. For instance, the facts, as they appear to me, seem to require that the flea should be able still to communicate the virus many hours, and even some days, after it has received it; but, however that may be, this and other such details can be investigated only in the laboratory, and can be determined only by direct experiment. In the meantime I venture to express a hope that the field of epidemic plague, which has hitherto been given over almost entirely to the bacteriologist, and to those who have relied on inferences drawn from his carefully-guarded experiments, may soon begin to be laboured by the professed epidemiologist, whose peculiar function it is to discover and exhibit the phenomena of communicable diseases as they are manifested under the variable conditions of daily life.

J. ASHBURTON THOMPSON.

APPENDIX.

Appendix.

TABLE showing Serial Numbers, Date of Attacks, Adjudged Places of Infection, and grouping of 139 cases of Plague, together with references to the paragraphs in which they are mentioned.

Serial Number.	Date of Attack.	Adjudged Place of Infection.	Area.															Reference number to paragraph in Report.
			South Central. 1	Paddington. 2	Chippendale. 3	Alexandria. 4	Waterloo. 5	Central. 6	Darling Harbour. 7	Woolloomooloo. 8	Camperdown. 9	North Central. 10	S.W. Central. 11	S.E. Central. 12	Pyrmont. 13	Not within any named area. 14	Undetermined. 15	
	1901.																	
1	4 Nov....	Exton's Store, Hay-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	77
2	8 Dec. ..	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	85
	1902.																	
3	10 Jan. ...	145, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
4	12 ,, ..	285, Castlereagh-street, City.....	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	97
5	16 ,, ...	145, New South Head Road, Paddington	...	•	...	...	...	...	..	...	...	...	...	..	...	...	...	90
6	20 ,, ...	147, ,, ,, ,, ...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
7	19 ,, ...	115, ,, ,, ,, ...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
8	19 ,, ...	147, ,, ,, ,, ...	...	•	..	...	...	..	...	...	...	..	...	...	...	...	...	90
9	4 Feb. ..	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
10	5 ,, ...	171, George-street West, City	...	...	•	...	...	...	...	...	..	...	...	...	...	...	...	101
11	6 ,, ...	8, Henderson-road, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	101
12	5 ,, ...	167, George-street West, City	...	...	•	...	...	...	...	...	...	..	...	...	...	...	...	101
13	7 ,, ...	165, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	92
14	10 ,, ...	165, ,, ,, ,, ...	...	•	...	..	...	...	...	...	...	...	...	...	...	...	...	93
15	10 ,, ...	342, Glenmore-road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	94
16	9 ,, ..	376, Pitt-street, City	•	...	...	..	...	...	...	...	...	...	...	...	...	...	...	100
17	11 ,, ...	217, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	94
18	14 ,, ...	Her Majesty's Theatre, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	212
19	14 ,, ...	,, ,, ,, ...	...	...	...	...	...	•	.	...	...	...	...	...	..	...	...	213
20	15 ,, ...	,, ,, ,, ...	...	...	...	...	...	•	..	...	...	...	..	...	...	...	...	214
21	12 ,, ...	,, ,, ,, ..	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	211
22	16 ,, ...	George Hotel, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
23	14 ,, ..	232, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	124
24	18 ,, ...	118, Crown-street, City	...	..	...	...	...	...	...	•	...	...	...	...	...	...	...	198
25	18 ,, ...	39, Sussex-street, City	...	..	..	...	...	...	•	...	...	...	...	...	...	...	...	127
26	19 ,, ...	Criterion Hotel, 258, Pitt-street, City..	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
27	22 ,, ...	,, ,, ,, ...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
28	22 ,, ...	224, Sussex-street, City	...	..	...	..	...	...	•	...	...	...	...	...	...	...	...	128
29	21 ,, ...	Criterion Hotel, 258, Pitt-street, City..	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
30	21 ,, ...	118, Crown-street, City	...	...	...	...	...	...	...	•	...	..	...	..	...	...	...	198
31	23 ,, ...	Criterion Hotel, 258, Pitt-street, City...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
32	22 ,, ...	,, ,, ,, ...	...	...	...	...	...	•	...	...	...	..	...	...	...	...	...	199
33	25 ,, ...	George Hotel, 186, Pitt-street, City ...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
34	24 ,, ...	47, Market-street, City	...	..	...	...	...	•	..	...	...	...	...	...	..	...	...	217
35	22 ,, ...	30, Botany-road, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	109
36	25 ,, ...	68, ,, ,, ...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	110
37	20 ,, ..	68, O'Connor-street, Chippendale.....	..	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
38	22 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
39	24 ,, ...	Criterion Hotel, 258, Pitt-street, City...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
40	25 ,, ...	,, ,, ,, ...	...	...	..	...	...	•	...	...	...	...	...	...	...	...	...	199
41	27 ,, ...	482, George-street, City.....	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
42	27 ,, ...	49-51, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
43	27 ,, ...	47, Market-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	217
44	27 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	..	...	...	...	•	45
45	1 Mar....	30, Botany-road, Alexandria.....	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...
46	3 ,, ...	General Post Office (?), City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
47	27 Feb....	17, Brisbane-street, City	...	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...
48	27 ,, ..	Undetermined	...	...	...	...	...	...	...	...	...	...	...	..	...	...	•	45
49	28 ,, ...	237, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
50	2 Mar....	Undetermined	..	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
51	3 ,, ...	251-257, Pitt-street, City	..	...	...	..	...	•	...	...	...	...	...	...	...	...	...	134
52	11 ,, ...	Central Exchange Coffee Palace, York-street, City.	...	...	..	...	...	•	...	...	...	...	...	...	...	...	...	204
53	11 ,, ...	,, ,, ,, ...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	204
54	10 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
55	12 ,, ...	155, King-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
56	10 ,, ..	123, Sussex-street, City.....	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
57	10 ,, ...	170, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
58	5 ,, ...	Undetermined	...	...	..	...	..	...	...	...	...	...	...	...	...	...	•	45
59	4 ,, ...	Barker's-lane, off Bathurst-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
60	13 ,, ...	Central Exchange Coffee Palace, York-street.	...	...	..	...	...	•	...	...	...	...	...	...	...	...	...	204
61	13 ,, ..	77, George-street, Camperdown	...	...	...	...	...	...	...	...	•	...	...	...	...	...	...	137
62	16 ,, ...	5, Chambers-street, City	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
63	15 ,, ...	Undetermined	...	...	..	...	...	...	...	...	...	...	...	...	...	...	•	45
64	14 ,, ...	13, Bridge-street, City	...	...	...	...	...	...	...	...	...	•	...	...	...	...	..	218
65	15 ,, ...	,, ,, ...	...	...	...	...	...	...	...	...	...	•	..	...	...	...	...	218
66	16 ,, ...	,, ,, ...	...	...	...	..	...	...	...	...	...	•	...	...	...	...	...	218
67	18 ,, ...	111, York-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
68	18 ,, ...	73, Engine-street, City	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...
69	13 ,, ...	425, George-street, City.....	...	...	...	..	...	•	...	...	...	...	...	...	...	...	...	204
			1		3	4	5	6	7	8	9	10	11	12	13	14	15	

Serial Number.	Date of Attack.	Adjudged Place of Infection	Area.															Reference number to paragraph in Report.
			South Central.	Paddington	Chippendale.	Alexandria.	Waterloo.	Central.	Darling Harbour.	Woolloomooloo.	Camperdown.	North Central.	S.W. Central.	S.E. Central.	Pyrmont.	Not within any named area.	Undetermined.	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	1902.																	
70	17 Mar....	13, Bridge-street, City	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...	218
71	16 ,, ...	13, ,, ,, ...	...	...	...	...	...	...	...	...	..	•	...	...	...	...	...	218
72	17 ,, ...	Barque "Eulomene" (excepted).....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	66
73	19 ,, ...	99, Wyndham-street, Alexandria	...	...	..	•	...	...	...	..	...	...	...	...	...	...	...	108
74	19 ,, ...	Undetermined	...	...	...	...	...	...	...	..	...	...	...	...	...	...	•	45
75	20 ,, ...	39, Market-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
76	16 ,, ...	105, King-street, City	...	...	...	...	..	•	...	...	...	...	...	...	...	...	...	134
77	26 ,, ...	109, Quay-street, City	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...
78	24 ,, ...	Saxton and Binn's timber yard, Blackwattle Bay.	...	...	...	...	...	...	..	...	...	...	...	...	•	...	...	220
79	22 ,, ...	14, John-street, Waterloo.....	...	...	...	...	•	...	...	...	...	...	...	...	...	..	...	112
80	25 ,, ...	134, King-street, City	..	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
81	25 ,, ...	Strand Arcade, Pitt-street, City.....	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
82	21 ,, ...	16, Dick-street, Chippendale, City.....	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	205
83	26 ,, ...	117, Gipps-street, Pyrmont, City	...	...	...	...	...	...	...	...	...	...	...	...	•	...	...	205
84	26 ,, ...	267, Pitt-street, City	...	...	..	..	...	•	...	...	..	...	...	...	...	..	...	134
85	27 ,, ...	119, Gipps-street, Pyrmont, City	...	...	...	...	...	...	...	...	...	...	...	...	•	...	...	206
86	27 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
87	28 ,, ...	,, ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
88	27 ,, ...	Union Co.'s Wharf, Margaret-street ...	...	...	...	...	...	...	•	...	...	...	...	...	...	..	...	267
89	22 ,, ...	Miller's timber yard, Duncan-street ...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
90	31 ,, ...	20, John-street, Waterloo.....	...	...	...	...	•	...	...	...	..	..	...	...	...	...	...	112
91	2 April..	119, Gipps-street, Pyrmont	...	..	...	...	...	...	..	...	...	...	...	...	•	..	...	206
92	29 Mar....	16, Dick-street, Chippendale.....	...	...	•	...	...	...	..	...	...	...	...	...	...	...	...	205
93	3 April..	137, Liverpool-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	..	...	100
94	3 ,, ...	Undetermined	...	...	...	...	...	...	...	...	..	...	...	...	...	...	•	45
95	16 Mar....	173, Goulburn-street, City	...	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...
96	5 April..	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
97	6 ,, ...	40, Riley-street, Woolloomooloo.....	...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...
98	13 ,, ...	1, Bourke-street, Waterloo	...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	112
99	12 ,, ...	Buckle's Wharf, Blackwattle Bay	...	...	...	...	..	...	..	...	...	...	...	...	•	...	...	220
100	18 ,, ...	3, Rennie-street, Redfern	..	...	...	...	...	...	...	...	...	...	..	...	...	•	...	181
101	16 ,, ...	Undetermined	...	...	...	...	...	...	...	...	..	...	...	...	...	...	•	45
102	18 ,, ...	89A, George-street West, City.....	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
103	19 ,, ...	Undetermined	..	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
104	20 ,, ...	Gillies' Bond, Grafton Wharf	...	...	...	...	...	...	•	...	...	...	...	...	..	...	...	124
105	20 ,, ...	66, O'Connor-street, Chippendale	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
106	20 ,, ...	2, Bathurst-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
107	23 ,, ...	60, Phillip-street, Alexandria	...	...	...	•	...	...	..	...	...	...	...	...	..	...	..	111
108	27 ,, ...	215, King-street, Newtown	...	...	...	...	...	...	...	...	...	...	...	...	...	•	...	146
109	26 ,, ...	31, Rag'an-street, Waterloo	...	...	...	...	•	..	..	...	...	...	...	...	...	...	...	112
110	24 ,, ...	Undetermined	...	...	...	...	...	...	..	...	...	...	...	...	...	...	•	45
111	28 ,, ...	,, ...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	•	45
112	27 ,, ...	26, Campbell-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
113	30 ,, ...	59, Goulburn-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
114	24 ,, ...	60, William-street, Woolloomooloo.....	...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...
115	4 May ..	Retreat-street, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	112
116	4 ,, ...	305, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
117	3 ,, ...	25, Campbell-street, City	•	...	...	...	...	...	...	...	...	...	...	..	...	...	...	100
118	26 April ..	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
119	5 May ...	,, ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
120	5 ,, ...	,, ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
121	8 ,, ...	,, ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
122	5 ,, ...	127, Crown-street, Woolloomooloo	...	...	...	...	...	..	...	•	...	...	...	..	...	...	...	...
123	6 ,, ...	Buckle's Wharf, Blackwattle Bay	...	...	...	...	...	...	...	...	...	...	...	...	•	...	...	220
124	12 ,, ...	72, William-street, Woolloomooloo... ...	...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	267
125	11 ,, ...	Gray's Stables, Elizabeth-st. Waterloo	...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	112
126	15 ,, ...	26, Campbell-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
127	13 ,, ...	49, George-street, Camperdown	...	..	..	...	...	...	...	...	•	...	...	...	...	...	...	139
128	16 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
129	15 ,, ...	252, George street, City.....	...	...	...	...	...	...	...	..	...	•	...	...	...	..	...	...
130	15 ,, ...	86, Windmill-street, City	...	...	...	...	...	...	...	...	...	..	...	...	...	•	...	41
131	20 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
132	20 ,, ...	69, Beaumont-street, Waterloo...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	112
133	28 ,, ...	Grimley's Tannery, Botany-road, Alexandria.	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	112
134	5 June...	Zoological Gardens	...	...	...	...	...	...	..	...	...	...	...	...	...	•	...	178
135	5 ,, ...	30, McEvoy-street, Waterloo	...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	112
136	1 ,, ...	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
137	2 ,, ..	77, Cooper-street, Waterloo	...	..	...	...	•	...	...	...	...	...	...	...	...	...	...	112
138	5 ,, ..	17, Botany-street, Waterloo	...	...	...	...	•	...	...	...	...	...	...	...	...	...	...	112
139	8 ,, ..	54, Morehead-street, Waterloo	...	...	...	...	•	...	..	...	...	...	...	...	...	...	...	112
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

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LEGISLATIVE ASSEMBLY.

NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

THIRD OUTBREAK OF PLAGUE AT SYDNEY,

1903.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President,

Chief Medical Officer of the Government.

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7th December, 1904.

ATTACK occurred in the last case of the preceding outbreak on 12th June, 1902; the last plague-rat was taken on 14th July, 1902. The outbreak now to be described began in an epizoötic of plague of which the first evidence was got on 12th May, 1903, and the last on 15th August, 1903. It consisted in occurrence of a case of plague in man, in which the date of attack was 17th June, and of one other in which the date of attack was 2nd July; both of these persons recovered. But it is necessary to review the plague-free period which preceded this third outbreak, as well as a part of the plague-free period which followed it; and therefore the account relates to the year and a half which lay between 15th July, 1902, and 31st December, 1903.

2. For descriptive purposes the term just defined may be divided conveniently into three periods, namely (*a*) from 15th July, 1902, to 30th April, 1903, being the preliminary plague-free period; (*b*) from 1st May, 1903, to 15th August, 1903, being the epizoötic period;* and (*c*) from 16th August to 31st December, 1903, comprising a large part of the ensuing plague-free period.

3. During the first period the agencies through which watch was kept on the state of the rat-tribe were a staff of rat-catchers attached to this Department, and a similar staff employed by the Local Authority under the Public Health Act for the City of Sydney; the former was under direction of the headquarters staff, the latter under that of Dr. W. G. Armstrong, M.B., D.P.H., Senior Medical Officer of Health for the metropolitan district and titular City Health Officer (*see* Sydney Corporation Consolidation Act of 1902, sec. 59). These rat-staffs continued to work as they had done for long before; that is to say, the Departmental rat-staff attended to that part of the wharf-line which extends from Pyrmont to the eastern head of Woolloomooloo Bay and to the buildings on, or immediately adjacent to, it (*see* Diagram); it also did some occasional work in suburbs outside the City proper. The City rat-staff attended to the whole of the City proper, except the wharf-line, &c. Both used the same methods. They employed traps exclusively, and that kind of open trap in which the animal's neck is broken as soon as it takes the bait, this having been considered to have proved the best form for continued use. Each man set about three dozen traps at night. Members of the Departmental rat-staff attached the addresses at which animals had been taken to each lot, and delivered the carcases at the Micro-biological Laboratory between 9 and 10 o'clock a.m.; there they were examined by a staff of experienced laboratory assistants under supervision of the Principal Assistant Medical Officer of the Government and Micro-biologist (Dr. Frank Tidswell, M.B., D.P.H.), who was responsible for all bacteriological determinations of

* Thus extended by eleven days for simplification of the analysis, in view of the probability that the epizoötic had begun some unascertainable number of days before the date of its discovery.

of plague in carcases, as well as in all specimens from the human body (for methods employed *see* Report, 1900, Appendices A and L, and Report, 1902, pars. 158 to 163). From the beginning of 1903 the Departmental staff was directed to confine its operations entirely to the wharf-line and adjacent buildings; and as it became important to know not merely where rodents had been taken, but also that all the wharves had been regularly visited, they were then instructed to make daily return of all the wharves at which they had set traps, whether animals had been caught or not.

4. Under these conditions 25,664 rats were taken by the two rat-staffs between 15th July and 31st December, 1902; 12,051, or an average of about 70 a day, being all which had been taken by the Departmental staff, were examined in the laboratory (*see* Report, 1902, par. 235). From 1st January to 30th April, 1903, 5,411 rodents were collected by the Departmental staff, of which 5,109 (or an average of about 44 a day) were examined in the laboratory. So that during the whole of the first term from the 15th July, 1902, to 30th April, 1903, 31,075 rodents were taken, of which 17,160 were examined in the laboratory: and they had been taken in neighbourhoods selected in accordance with the experience which had taught that recurrent plague would probably first betray itself in them. None of the 17,160 were infected with plague. Additionally, a few had been handed in occasionally by the City staff, all of which were also healthy; the Senior Medical Officer of Health had reported that nothing to arouse suspicion had been observed in the inland parts of the City which were more immediately under his notice; and on the whole it appeared on 30th April, 1903, to be probable that Sydney had for eight months and a half been really free from plague in its rats, as it certainly had been free from plague in man.

5. Before passing on to speak of the rats collected during the second of the three periods, other work which had been done, and which was still being steadily continued, must be mentioned. In accordance with the general teaching of the two earlier outbreaks (*see* Reports, 1900 and 1902, *passim*) attempts had been made from a very early date to cause Local Authorities under the Public Health Act to render warehouses and food-stores of all sorts, but especially produce stores (in which chaff, hay, maize, lucerne, potatoes, and the like are kept) less accessible to rats, and less likely to harbour them, by obliging owners to make good casual openings in walls and doors, to defend permanent openings with wire-netting, and to substitute solid concrete for wooden flooring in basements. Within the City the Local Authority had most earnestly and most persistently taken up this line of preventive work, and had prosecuted it with much success; and it had done so especially on the eastern side of Darling Harbour, where not only is the produce trade chiefly carried on, but where also the two preceding outbreaks had beyond reasonable doubt taken their local origin. This neighbourhood fell under two authorities. The premises on the western (or water) side of Sussex-street, were vested in the Harbour Trust; those on the eastern side of that street were occupied by various owners in the usual way: But both of these parties were equally subject to the provisions of the Public Health Act under administration within the City of the City Corporation. On the water-side of this street, then, the work now referred to had been steadily prosecuted by the Harbour Trust during the preceding two years, and many (but far from all) premises had been put into satisfactory condition. As regards the eastern side of the street and the rest of the City behind it, the Senior Medical Officer of Health had, in 1901, formed the opinion that progress in this direction would be facilitated by special by-laws, and had presented a code to the Local Authority for the City, which was adopted by it, and which had come into force on 20th February in that year. Then, in view of the dissemination of plague *per saltum* which had so often been observed—a mode of diffusion in which the infection is conveyed with produce from the focus to some distant store, where it is communicated to the local rats and may form the starting-point of an independent sub-epidemic (*see*, for instance, Report 1902, Paddington, Alexandria, &c., &c.), a Model Code of By-laws was framed by the Board to empower Local Authorities to effect similar improvements in municipalities outside the City. All Local Authorities in the Metropolitan District were invited to adopt this Code, which is printed in Appendix B. There also is shown the proportion of them which voluntarily adopted it, and the number in respect of which the Board ultimately had to exercise the powers of compulsion conferred upon it by the Public Health Act of 1902, section 25. Within the City, then, and more especially in that part of it which experience had shown to be most fraught with

danger

danger in relation to plague, much preventive work of great importance had been effected, and still was being effected when this third outbreak began, first by the Local Authority for the City under advice of the Senior Medical Officer of Health, and secondly by the Harbour Trust voluntarily working towards the same end with advantage of the same advice. That end was the keeping of rats outside premises, in accordance with the most important of the practical conclusions drawn from the teaching of the first outbreak (Reports, 1900, p. 47, and 1902, par. 9).

6. Description of the second period, or that during which epizoötic plague was again observed may now be entered upon; it is dated 1st May to 15th August. On 8th May a firm of produce merchants trading at 153 Sussex-street (on the western, or water, side), made a communication to this Department in consequence of which rat-catchers were told off to watch the premises. They succeeded in catching one rat on the night of the 8th, and another on the 10th; both were healthy. On 12th May a further message was received, in response to which Departmental Sanitary Inspector Lloyd was sent down; he collected three carcases, of which one was putrid, one was healthy, and one (of a rat which had been killed by a dog in his presence) was infected with plague, as revealed by the positive results of the morphological and cultural tests applied to it by the Microbiologist. Exit of stock from the premises was at once prevented, and a large gang of men was put in to turn it over. On 13th May, this gang delivered two more carcases at the laboratory, both of which were infected. The stock consisted of maize and chaff. The bags in which the maize was contained were in good order, and were not further interfered with; but many of the chaff bags were broken, and it was thought prudent to cause 650 of them to be sent to a garbage destructor, in which they and their contents were destroyed by fire. In the course of doing this two rats happened to be seen to issue from one of the bags. The premises were part of a row of five houses all similarly constructed, and all in free communication with each other for rats. Sussex-street, at the part now referred to, ran along a low cliff, so that these and some other buildings had but one storey visible from the street, but other two storeys below it which could be entered at the wharf-level behind. Of the three floors of which the building thus consisted, the lowest had been concreted by the Harbour Trust; the other two were of timber, not ceiled. The premises were clean and well-kept, although very old, and presented little harbourage for rats except among the stock.

7. As soon as recurrence of infection among the rats had been thus discovered, the strength of the Departmental and of the City rat-staffs was increased; and the latter was then directed to attach addresses to its takes, and to deliver all carcases at the Microbiological Laboratory. The Board also determined that it was expedient again to offer a capitation-payment of 6d. for each rat brought in by the general public, and to this was added, for the first time, a capitation payment of 1d. for each mouse. No other limit could be set to the area over which rats might be gathered by the public than that of the metropolitan district; and it was considered that, as a rule, no trustworthy statement as to the premises on which particular rats had been taken could be got from them. A furnace was re-established at a convenient point where the officers in charge were chiefly employed in counting, paying for, and burning the rats tendered to them; but they also had instructions to make such inquiry as was possible, and to note any information of importance which came to their ears. In this way a few enterprising people who thought it worth their while to import parcels of rats from a distance were checked, and occasionally an item of information of more or less value was picked up; but, on the whole, payment of capitation money must be regarded only as a means of securing the destruction of rats. This result must be sharply distinguished from that attained by agency of the organised and carefully supervised rat-staffs, which latter are rather a means of getting intelligence than of destruction.

8. The general plan of action in relation to search, and to treatment of premises on which infected rodents were discovered, was the following:—While 153 Sussex-street and some adjacent buildings were being examined by Departmental officers (operations which resulted within a few days in detection of infected rodents at Nos. 151, 139, and 129*, see Appendix A) a special gang of men, which included a plasterer, was put at disposal of the Senior Medical Officer of Health by the Harbour Trust, which, under his direction and that of the Trust's Engineer, went systematically through the Trust's property on the water-side of that street. A similar gang was reorganised

* All odd numbers in this street lie on its water side.

reorganised by the Local Authority for the City, which went through other properties in that immediate neighbourhood on the eastern side of the street, as well as elsewhere within the City. The plasterer's business was to stop the rat-holes which were very numerous in the old, thick, rubble-built walls of some premises. In this way a great deal of work was rapidly done of a kind which experience had shown to be of the greatest importance in checking epizoötic plague. It consisted primarily in moving and re-stacking stocks of fodder and produce, examining them for live or dead rats, cleansing where necessary, and stopping rat-holes permanently; secondarily, in serving notices on the Harbour Trust and on other owners requiring them to defend permanent openings with wire-netting, to repair casual openings, to remove wood-flooring in basements, and to substitute concrete for it. When either of the intelligence-staffs delivered a plague-rat at the laboratory the information, if it concerned premises within the City, was communicated to the Senior Medical Officer of Health, who at once entered the premises on which the animal had been taken, and the premises on each side of them as well; he also concentrated his intelligence-staff in the neighbourhood. If it concerned premises outside the City, similar steps were taken by the Departmental staff, other Local Authorities having been rarely in a position to take effective action with the necessary promptitude. I have no doubt that by these thorough measures—aided by the autumn and winter seasons which, however, I do not suppose to have acted in any of those obscure ways usually classed as "meteorological"—spread of the epizoötic was interrupted, delayed, and ultimately checked, and that development of an epidemic was prevented; for at Sydney epidemic plague has always been directly dependent on epizoötic plague. There the rat has been the sole source of infection for man (Cf. Reports 1900 and 1902 *passim*).

9. Now, as regards rodents taken during this second period, 1st May to 15th August, the two intelligence-staffs delivered at the laboratory 8,695 rats and 5,976 mice, all of which were there examined. Of the total 14,671 rodents (which were examined at the rate, therefore, of just under 1,000 a week, or about 166 a day), 111 rats and 50 mice were ascertained to be infected with plague. The last plague-rodent was brought in on 15th August. The Departmental staff had still confined its attention to the wharf-line as defined in paragraph 3.

10. Then, as regards the third period, namely, from 16th August to 31st December, 1903, the number of rodents collected by the two intelligence staffs was 8,485 rats and 4,904 mice, total 13,389. The deliveries were at the average rate of about 111 a day; all were examined in the laboratory, and none were infected. The Departmental staff had continued to attend to the wharf-line. Thus, at the end of 1903 it once more appeared that Sydney was free from epizoötic plague, and that it had been so for four months and a half.

11. The results achieved through the offer of capitation-money may be briefly reviewed; but as these consisted merely in destruction there is no object in dividing the period, and the whole term from 30th June, 1903, when capitation-money began to be paid to the end of the year may be dealt with at once. During that term of six months 46,472 rats and 22,814 mice were paid for. The record showed that the numbers delivered at the furnace varied very widely between a maximum of 666 and a minimum of 118 a day for rats, and between 322 and 28 a day for mice; but if the gross returns for successive weekly periods were considered, it appeared that these were nearly uniform. Thus the account yielded no evidence that this slaughter (to which should be added the number collected by the intelligence-staffs during the same six months, the whole furnishing a grand total of 88,829 rodents destroyed) produced such an impression on the general horde as rendered collection progressively more difficult; and there was no ground for inferring that any material impression had been thus made on the total rat-tribe. This result was in accordance with the opinion I expressed at first (Report, 1900, p. 47, for instance) namely, that extermination of rats on any large area was practically impossible;* and perhaps no more could be expected from such operations conducted in a district which carried residences housing about 500,000 persons, as well as other buildings. It is fortunate, therefore, that repeated experiences have shown that very strenuous efforts to destroy rats need be made only on those premises, and in their immediate neighbourhood, to which the discovery of one or more plague-rats by intelligence-staffs has directed

* By the methods described above. Further attempts to employ Dr. Danysz' cocco-bacillus usefully are being made.

directed attention; and, further, that during plague-free intervals the work of intelligence-staffs may be concentrated on and confined to that neighbourhood which local experience has shown to be the focus of danger for the city to be defended, or at least to be the locality in which a fresh outbreak is most likely first to take place.

12. One other note may be made, which concerns the difficulties which rat-catching appears to present even to experienced men. The figures now to be mentioned in illustration of this point, are to be regarded apart from those given above, under which they have already been included. During the eight months between 1st May and the end of the year the Departmental intelligence-staff paid 17,656 visits to wharves, piers, foreshores, &c., and to the open or bonded stores and sheds immediately connected with them; but only 4,095 of those visits were successful (or, resulted in captures), and the number of rodents taken was only 10,579 (Cf. Report 1902, par. 114). The premises thus examined were freely open to the appointed rat-catchers, yet their efforts were successful only in about 25 per cent. of their attempts. It will not fail to be noticed that when the object is to investigate a residential area, on which such efforts are impeded by the not unnatural reluctance of householders to admit men who are not personally known to them to their premises at night, the thoroughness of the search actually made, and consequently the value of any negative statement in which it may result, remains doubtful. Nevertheless, experience has shown that such searches have a greater practical value than the facts strictly reviewed would seem to warrant.

13. Before bringing this statement to a conclusion attention may be directed to the extremely small proportion borne by the number of rodents in which plague was identified to the total rodents taken. Such a rate must be struck, of course, with carcases in which plague was identified, on the rodents taken and submitted to examination during that term (the second) which was defined by the first and last findings of plague-infected rodents; and the total can comprise only the rodents taken by the intelligence-staffs, because there is no evidence that the epizoötic extended at any time beyond the neighbourhoods in which they worked. Under these limitations the gross percentage of plague-rodents identified was no more than 1·27 per cent. for rats, and 0·83 per cent. for mice; and the smallness of these percentages is accentuated by the fact that of the total 161 plague-infected rodents, no less than 78 were collected from one premises (a secondary focus; Gray's stables, Waterloo, *see* par. 25 below). If this number be subtracted from the total, then it appears that only 83 plague-rodents were identified in the whole of the infected district which included the original focus and all areas (except Waterloo) infected from it; so that the percentage of identified plague-rodents to the total taken by the intelligence-staffs falls to ·55 per cent. for rats, for mice to ·58 per cent., the gross percentage having been ·56 per cent. But there are several considerations which show that such comparisons, if they are made with a view to gauging the severity of an epizoötic, are illusory. The most important of them has been mentioned already (Report, 1902, par. 115); it is that the only methods practically available to rat-catchers tend to ensure capture of healthy rats for the most part. Those alone are taken in traps (as a rule) which are in good health, and which enter them in course of their active search for food, or, if infected, have not reached a stage of illness at which pathological signs have appeared. Hence the percentage of identified plague-rats thus calculated must always be extremely small. An additional reason can be assigned for the low percentage which our accounts show; this attaches to the manner in which I think it best to state the facts. A considerable number of carcases have been delivered at the laboratory in a state too putrid for useful bacteriological examination, but in which there was every reason to think plague had been the cause of death; and were these counted as plague-rats the percentage would be increased. But I do not think the term "plague-rat" should be applied to any carcase in which the disease has not been identified; and I do not think that the term "identified" should be employed unless the presence of *B. pestis* has been bacteriologically demonstrated.

14. From all this it follows that percentages so struck are useful only in as far as they show the practical difficulties there are in the way of capturing plague-rats, and of identifying the disease which has destroyed them (Cf. Report 1902, par. 5, and elsewhere); a difficulty which, so far, has been generally overlooked, and which, I think, has not been fully appreciated by all even of those who have attempted

attempted to investigate rat-plague in a practical way, but by methods insufficiently systematised. Until it shall have been clearly recognised, and the full weight allowed to it with which it is invested by ascertained facts, the rôle of the rat in relation to epidemic plague will continue to be generally considered obscure.

15. It also follows that if it be desired to measure the extent to which an epizoötic of plague has been fatal, the rate must be struck with plague-rats identified at particular premises on the total rats infesting them. But here, again, difficulties will be met with which are quite insuperable. In the first place, the number of the horde which infested the building never could be ascertained; in the second, certainty that the plague-rats identified comprised all which had died of plague never could be reached. For, while in several instances which have been already recounted (Report, 1902, pars. 78, 84, 106, 111, 145, 201, and par. 25 below) very considerable numbers of carcases have been found, the rule has been to find but few, even on premises where it seemed certain the disease had had every opportunity of spreading. This I have ascribed to death of many of the infected animals in burrows, and to the eating of some carcases by other rats.* If it should be suggested that the former might be dug out, it can be replied that apart from all considerations of time, &c., this often could not be done with safety to the building, and even that cases have occurred in which all dead rats could not have been uncovered except by destruction of the lower part of its walls. The practical conclusion, therefore, is that which has already been stated (Report 1902, par. 118); intelligence-staffs can indicate the area over which an epizoötic has extended, but not its severity. Consequently, the identification of plague in a single carcase is a sufficient and an urgent call for presence of the cleansing-staff on the premises which yielded it, and for concentration of the intelligence-staff in their neighbourhood. The present account shows clearly that action thus guided, and promptly taken, may be successful in limiting and checking an epizoötic, and in avoiding occurence of a general epidemic.

16. From the foregoing statement we may proceed to investigate the localities in which plague-rodents were detected. The total 161 were taken on 25 separate premises (including the barque "Alsterschwan"), between the 12th May and 15th August. The position of each place is shown on the accompanying Diagram by spots; these are consecutively numbered in order of the earliest date on which a plague-rodent was observed at each place. In a Table printed on the Diagram are shown the addresses of the places, and these are consecutively numbered to agree with the numbers affixed to the spots; to each address is appended the earliest and the latest date on which plague-rodents were found at it. The course of discovery can be easily followed with this assistance, but this must not be taken without reserve as indicating the progress in place of the epizoötic itself; for although it appears that freshly-infected spots were discovered as a rule soon after the infection had reached them (because very little evidence of local spread from such spots was acquired in spite of close search for it), yet some delay must generally have occurred, so that it is not likely they were discovered precisely in the order in which they became infected.

17. If, now, these 25 infected places are considered in detail after examination of the local conditions in the light of previous experience, it appears that they may be divided into four clearly-distinguishable groups. Thus, in consideration of the negative evidence furnished by the long-continued watch kept on the rats, and especially on the rats of the wharf-line, which has already been described (pars. 3, 9, 10) it seems probable that the Diagram numbers 1, 2, 3, and 4 indicate the neighbourhood of original infection or primary focus, and that the numbers 6, 9, 7, 10, 12, 13, 14, 17, 18, 19, 20, 21, and 23, most probably indicate gradual spread from it by contiguity, although there is a possibility that some of them indicate places to which the infection was conveyed *per saltum*. The numbers 5 and 8, situated far away from the primary focus on the shores of Woolloomooloo Bay, indicate points to which the two infected carcases to which they refer must have been conveyed either overland

* About 8 per cent. of carcases delivered at the laboratories are found to have been gnawed or partly eaten. But, although this figure results from test-enumerations, circumstances connected with administrative exigencies reduce it to the status of an estimate. Each rat-catcher must, in the course of each week, hand in a certain minimum number of rats which is accepted as evidence of his attention to duty; and only those carcases can be credited to him which are approximately entire, for if a head or hind-quarters were counted one rat might be made to swell the credit of two men. Now, a considerable number of rats (the proportion is not known) are so eaten that heads separated from the remains of hind-quarters are all that is left of them; and as these pieces are not counted, so they are not often brought in.

overland with goods or by water; and perhaps these two specimens comprised all which were present there, for long-continued search among the wharves and among the houses in their vicinity failed to furnish any evidence of spread of the infection to the local rats. After two months of this search a further single plague-rat was brought in from land attached to an unoccupied private residence standing at the eastern head of this bay (Diagram, No. 22); but in this case again watch was continued afterwards and failed entirely to reveal any infection of the rats in that neighbourhood. It must be supposed, therefore, that this animal also had in some way been carried to the place where it was found. With these instances of transported plague must be included those indicated by the numbers 12 and 13, for these wharves were not only rather distant from the primary focus, but were effectually separated from it on the wharf-line by a large gas-works, as well as in other structural ways; and it may be noted that they were in the neighbourhood of a China wharf to which much fodder, consigned to China, was from time to time conveyed from Sussex-street stores. Lastly, the number 25 must be added to this group; the solitary carcase to which it refers having most probably been transported to the place where it was found, in which no other infected animals could be discovered. The numbers 11, 15, and 16 remain; they are grouped together at a point 2 miles to the south of the primary focus. Doubtless the infection was transported with produce to 11, which was a large stable. The premises afterwards formed a secondary focus from which infected rats spread by contiguity to 15, a soap-works near by, and to 16, a street at some little distance in a different direction; but general infection of the rats in the neighbourhood, although they were numerous, did not occur. Lastly, 24, indicates a ship alongside to which, as well as to the stables just mentioned, further reference will be made below.

18. Thus it is possible to distinguish an original focus, spread from it in its immediate neighbourhood by contiguity, and infection *per saltum*, of at least three distant points; namely, Woolloomooloo Bay, Miller's Point, and the stables at Waterloo. The latter premises afford a further instance of the manner in which secondary foci may become established which is on all-fours with several previously described (Report 1902, Paddington, Alexandria, &c., &c.,) although it was not followed by any epidemic.

19. The course of the epizoötic just described was marked by occurrence of two cases of plague in man. Time-relations are shown in the Table printed on the Diagram, on which, also, the places at which the patients were employed are indicated by the capital letters A, and B, while the situation of the dwellings they occupied is indicated by the corresponding lower-case letters within a circle. The particulars of the first case were as follows:—

CASE A.

Summary.—W.W., m., aged 15, 9/12; apprentice at a printer's. No former attack; not inoculated. Residence, View-street, Annandale, a suburb about 2 miles westerly from his place of employment, which was at 44, Pitt-street, City. Notified by a friend 20th June; visited 20th June by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Annandale, 12·30 p.m.; admitted to hospital, 20th June; discharged, 20th August; duration of illness, 65 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Had gone to work regularly for several weeks before attack; went and returned by ferry-boat; left work at 5·30, and had travelled by the 5·50 boat for a long time past; took his lunch with him from home, ate it at the shop, or sometimes on Circular Quay near by; in the evening often went to see a friend at Balmain,; Sunday, 14th June, on which date the seventy-two hours preceding attack commenced, was spent as follows:—Stayed at home till 2·45 p.m., went to Sunday-school till 4 p.m., from then till 5 p.m. sat in Wentworth Park, returned home and stayed there. Said that about 10th June he and another apprentice (who was ill at the date of inquiry, was visited, and was found to be free from suspicion of plague), had killed a rat in the composing room; the premises swarmed with fleas.

History of Illness.—June 17th, was well on rising; went to work as usual; at midday began to feel pain in the left groin and in back of head and neck; vomited several times; ate some lunch, but vomited immediately afterwards; got worse, and went home at 3·30; medical advice was not sought. Subsequent symptoms were pyrexia, vomiting, headache, and delirium, especially at night; the bubo increased and became more painful. At examination, 20th June, mid-day, the gland was as large as a pigeon's egg, some periadenitic effusion, tender. No breach of the epithelium of left lower extremity (nor elsewhere).

Residence.—A brick cottage of two rooms; semi-detached; state of repair and cleanliness, fair; pail-closet. It stood next to a large box-factory. Disinfected 20th June.

Employment.

Employment.—A brick building of five storeys, occupied by a printing firm (job; paper from England, America, Holland, and Belgium, after passing through Sydney warehouses); good repair; fairly clean; construction good, but ceilings of wood or iron in some rooms; lighting, ventilation, draining, and inside fittings excellent, and in good order. Cleansed and searched by large staff of employees under direction of Departmental officers, Sunday, 21st June.

Rats.—At residence, no signs; said none had been seen, but mice some weeks before, driven away by cats procured for that purpose. At the box-factory it was admitted a few rats were present; there was plenty of harbourage for them; but on examination it appeared that great care was really taken to avoid attracting them, and there was no sign of infestation; notices forbidding scattering of broken food were found posted, and proper boxes for it provided. At employment all agreed that no rats had been seen since 1902 (but see patient's statement, corroborated by fellow-apprentice); no signs of infestation; one rat-skeleton found, only; ceiling-spaces free; openings in basement walls afforded entry for outside rats.

Contacts and further Cases.—At residence, 4; at employment, 48. No further case at either place.

20. It will be noticed on the one hand that no direct connection with plague-rats was established in this case; but, on the other, that the circumstances appeared to exclude every other source of infection as well. In other words, it is manifest that some circumstance has remained undiscovered which was of determinative character in relation to attack.

21. The second case occurred a fortnight later.

Case B.

Summary.—R.H., m., æt. 20, unmarried, master-tinsmith. No former attack; not inoculated; had had no communication with the previous case. Residence, Summer Hill, a suburb distant about 4 miles westerly from his place of employment, which was at 125, Sussex-street, Darling Harbour. Notified by Dr. Lawes, 4th July, afternoon; visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Summer Hill, 2 p.m.; admitted to hospital 5th July, morning, discharged 5th August; duration of illness, 35 days. Right femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Had regularly attended at his workshop for long before his attack; his business caused him to visit many shops and warehouses which stood in Sussex-street, and elsewhere in that neighbourhood; lunched daily at a place in Erskine-street, two doors from Sussex-street; 27th June attended a football match; and on the 28th visited the Coast Hospital to see a workman suffering from typhoid fever, who lay in a ward half-a-mile from the Infectious Diseases Division, in which Case A then was.

History of Illness.—2nd July, felt out of sorts on rising; went to the workshop as usual, and remained till evening, but felt very ill, shivered, and vomited several times; 3rd July, evening, first felt a pain in right groin; 4th July, afternoon, was found in bed, looked ill, headache, photophobia, T. 102·4, P. 84, dicrotic; right femoral bubo not larger than a hazel nut, some periadenitic effusion, very tender. No wounds of leg or foot, but many faint marks which may be flea-bites.

Residence.—Brick-built, two storeys, detached, clean, comfortable, connected with sewers; in all respects in good order. Two rooms occupied by patient were disinfected 5th July.

Employment.—Nos. 123–5–7 Sussex-street are contained within the same external rubble wall, and are very old. Two storeys show above street-level, two storeys below it open at rear to wharf-level. Basement, concrete floor, is a bonded store; next above is a produce store; Sussex-street, or ground-floor, occupied by offices and patient's large workshop; upper floor, a printer's. There were ceilings, and some double matched-board partitions. Premises fairly clean. A gang of twenty men was put in by the Local Authority for the City under the Senior Medical Officer of Health, Metropolitan District, 6th July.

Rats.—Residence was free from any sign of infestation. At patient's place of employment carcases of rats and mice were discovered as follows:—Basement, 9 rats, 1 mouse; upper basement, 1 rat, 5 mice; ground-floor (in part occupied by patient), 3 rats; in a wing at rear, 4 rats; 18 live mice were also caught. The carcases were putrid: the live mice were healthy; but on July 8th a mouse and a rat infected with plague were taken at No. 123, which building was one with No. 125; and on 9th July, 3 rats and 7 mice infected with plague were taken at No. 129, next door to the building which contained Nos. 123 to 127. There is no reason, therefore, for doubting that the unusual mortality discovered at No. 125 had been caused by plague.

Contacts and further Cases.—At residence, 4; at workshop, 4. No further case at either place.

22. In this instance direct connection with rats affected by disease was clear, although plague was not identified in any of the carcases because they were delivered in too putrid a state; two of them were found on the roof of a little glass-enclosed office which was erected in one corner of the large workshop. But on 8th July plague was identified in a rat and in a mouse taken at No. 125, which, as explained above, was structurally the same building as No. 123.

23. A third case of plague came to notice, which occurred on a coasting steamer; the place of infection could not be certainly indicated, but as the balance of evidence pointed strongly to Brisbane, it has not been debited to Sydney. However, the following are the facts:—

CASE ON THE S.S. "INNAMINCKA."

On 5th September, the Commissioner of Public Health, Queensland (Dr. B. Burnett Ham, M.D., D.P.H.), notified detection of a case of plague in a seaman on board the Adelaide Steamship Company's "Innamincka," at Townsville. He further said that the diagnosis had been established by the Government Bacteriologist (Mr. C. J. Pound), who had reported that the morphological, cultural, and inoculation tests applied to liquid extracted from the swollen right inguinal gland which the patient exhibited had all yielded positive results.

The "Innamincka" was a coasting steamer of 2,500 tons, trading between Sydney and Melbourne to the south, and between Sydney and North Queensland ports to the north; the round trip usually extended from Melbourne to Cairns, Queensland, the port of Sydney being entered on both northern and southern voyages. It occupied about 28 days.

A.H.D., æt. 26, A.B., had sailed in the "Innamincka" for eighteen months before his death. The ship's master and chief mate considered him the most trustworthy member of the crew. He was perfectly steady, and neither smoked nor drank. He was married; his wife and child lived at Drummoyne, a suburb of Sydney. His wife was questioned; she said he always went straight home after his work while the vessel was in port, and as far as she knew he had not visited any other house than his own during the ship's last stay; she last saw him when he left home on the morning of 29th August; he was then perfectly well; he had no wounds about the body. She showed a letter from him which was posted at Brisbane on 31st August, in which he said he was "in the best health." On return of the vessel to Sydney it was learned that A.H.D. had gone ashore at Brisbane on the evening of the 31st August; he was met, returning to the ship, by the carpenter, who asked him where he had been, and was told "to post a letter, and to buy a newspaper and some prawns,' which latter he was eating at the time. The vessel left Brisbane on 1st September at 3 p.m. On 3rd September he was at the wheel at 3 a.m., when he complained of feeling ill, was relieved, and went below. The "Innamincka" went alongside at Townsville, Queensland, early on 4th September; the patient was removed to hospital at 9·30 a.m., where he died at some time on 6th September.

The "Innamincka," after her previous voyage, had arrived at Sydney from Queensland ports on 20th August, at 6 a.m.; had berthed at Grafton Wharf, Darling Harbour; had visited the Colonial Sugar Company's Wharf, at Pyrmont, and had sailed for Melbourne on 21st August, at 6 p.m. She returned from Melbourne, and arrived at Sydney 27th August; berthed at Grafton Wharf; left Grafton Wharf for Queensland ports on 29th August, at 1 p.m. She again reached Sydney on her return voyage from Queensland, on 17th September, at 2 p.m. On arrival the vessel was arrested for inspection, but was allowed to go alongside immediately afterwards, no further illness having occurred on board. Rat-catchers were sent on board, and, notwithstanding reported fumigations for destruction of rats at Townsville and Cairns, Queensland, they delivered fourteen at the laboratory, all of which were healthy.

At Sydney the first plague-rat detected in 1903 was identified on 12th May; the last on 15th August. The "Innamincka" always lay at Grafton Wharf, which is one of 15 situated between the Gas-works and Erskine-street, on the eastern side of Darling Harbour. The records of work done by the Departmental rat-staff showed that these 15 wharves had been visited 149 times during August, 1903; 63 rodents had been caught at them and subsequently examined in the laboratory, all of which were healthy except a rat taken at Huddart Parker's goods wharf on 6th August, and a mouse taken at the same place on 11th August; these had plague. This wharf lay rather less than 300 yards south of Grafton Wharf. Special attention was directed to Grafton Wharf and the bonds connected therewith for a time after notification of A.H.D.'s case; visits were paid to it on 6th, 8th, 9th, 10th, 11th, and 13th September, when 22 rats and 31 mice were taken and examined in the laboratory, all of which were healthy. No plague-infected rodents were discovered later than 15th August (at a place remote from this wharf) either in this neighbourhood or anywhere else in Sydney, although the regular search along the wharf-lines continued.

As regards Brisbane, the Commissioner for Public Health has been good enough to inform me that the last case of the 1903 outbreak had been notified on 23rd May, and the last plague-rat had been identified on 8th June; between the latter date and 11th September (95 days) 3,424 rats and two mice had been examined by the Government Bacteriologist, and none had been found infected. But on 11th September 2 cases of plague were notified, and on 26th September 2 plague-rats were identified, all in central parts of Brisbane. From these facts it may be inferred that Brisbane was probably infected in its rats at the time at which A.H.D. landed there, namely, 31st August, on his last voyage.

Three sources of infection lay open to the patient, therefore; these were Sydney wharves, the vessel itself, and Brisbane. Melbourne wharves were under no sort of suspicion then or later, and may be safely excluded. Nothing at any time appeared pointing to infectiveness of the vessel, so that choice lay between Sydney and Brisbane. At what time was the patient infected? From his having been obliged by his illness to leave his post at the end of the third hour of the middle watch on 3rd September, it may, perhaps, be inferred that he was then attacked, or, at all events, that his attack probably began during that watch—say at midnight. He had left Sydney at 1 p.m., 29th August; that was the latest moment at which he could have been infected there. The interval between his *arrival* at Sydney on this voyage and the time of his attack was about 156 hours, and from the time he *left* Sydney it was 108 hours. From the time of his *arrival* at Brisbane to the hour of his attack was 59 hours, and from the time he *left* Brisbane it was 35 hours. In a case of bubonic plague the period of incubation is very unlikely to exceed 72 hours, and most often it is considerably shorter; yet, as it sometimes extends to 96 hours, and perhaps even somewhat longer, although it has been thought to have done so only in very rare cases which, as a matter of observation, are of doubtful validity, the possibility of his having been infected at Sydney cannot be positively excluded on that ground.

While the general search, and the abovementioned special searches, failed to detect any plague-infected rodent after 11th August at the line of wharves of which Grafton Wharf was one, or at any other part of Sydney after 15th August, subsequent events showed that the infection may well have been present in Brisbane many days before the two cases in man were notified on 11th September. A decision as to the place at which A.H.D. was infected is, of course, not possible; but, in my opinion, the balance of reasonable probability inclines to Brisbane.

24. During the epizoötic term, plague-rats were discovered on a vessel alongside, which had arrived from Buenos Ayres; and, as this was the second vessel (only) on which plague-rats have been observed during the four years 1900-3, the following account is placed on record:—

THE BARQUE "ALSTERSCHWAN."

On 18th September, the barque "Alsterschwan" 2,500 tons, left Tacoma, Washington, with a full cargo of wheat, and arrived at Callao, December 14th, 1902. She discharged, took in ballast, and sailed for Buenos Ayres, 4th March, 1903. She arrived at Buenos Ayres 15th April, and anchored in the stream; the Master alone went ashore. Sailed for Rosario, 17th April, arrived 20th; lay in the stream, discharged ballast into punts, and took in a full cargo of maize by means of chutes resting on a cliff about 60 feet high, below which the vessel lay, and left Rosario 17th May. 1st June, she came to an anchor 20 miles off Buenos Ayres, and the same day sailed for Sydney. Arrived Sydney, 29th July, and was reported by the Port Health Officer (Dr. C. W. Reid) as follows:—Crew 26, no passengers; clean bill, good health, good sanitary state; full cargo of maize in bags.

On 29th July, the "Alsterschwan" anchored in the stream for two or three days, awaiting a berth, and then went alongside at Darling Island. On 3rd August, one of the crew offered 112 rats at the public depôt; this occurrence was at once reported to the Department. On inquiry into the circumstances, the Master said that the rats had been found dead near the ventilators as soon as the hatches began to be removed; and he added that, with some idea of saving the cargo, the holds had been closed much more carefully than usual, and so as to prevent entrance of air as much as possible. To this he ascribed the mortality.

The rat-catchers were directed to secure further specimens, and on 4th, 5th, 6th, and 7th August delivered 1, 9, 25, and 16 rats, all of which were examined in the laboratory; 2, of the 16, were found to be infected with plague. Further numbers were delivered on 8th and 11th August (the latter after fumigation), among which were 6 and 3 infected carcases.

Immediately after receipt of report from the laboratory, the Master was directed to hoist the yellow flag, and to haul off into the stream, while landed cargo was arrested. Instructions were given for fumigating the vessel with the Clayton Apparatus on two successive days, with an interval between the two fumigations of not less than twelve hours. This was done on August 8th and 9th, the engine having been reported by the Chief Sanitary Inspector to have worked on the first day from 9·30 a.m. to noon, when tests showed 20 per cent. gas in the holds; all was then securely closed down, and not reopened till 6 a.m. on the second day. The second fumigation began at 10·30, 9th August, and afterwards the hatches were again left closed till 10th August. After aeration the vessel was allowed to go alongside again, and to resume discharging under supervision. No live rats were seen.

The vessel was under orders to proceed to Newcastle after discharging at Sydney, there to take in a cargo of coal. She carried no ballast, and relied for stiffening on about 650 tons of maize which were consigned to Newcastle. To have caused her to discharge this also at Sydney (as was desired in order to search for and remove all carcases of rats) would have obliged her to take in 500 tons of coal instead by way of ballast. The course usually taken under similar circumstances with produce-stores, warehouses, &c., ashore was directed: this portion of the cargo was turned over under supervision of Departmental inspectors; faulty bags were emptied and their contents replaced in new bags. This, and a general cleansing and search, occupied about five days, during which the vessel was hauled off from the quay. 117 carcases were discovered in various parts of the vessel, and no live animal was observed. Thereupon the ship was released, and sailed for Newcastle.

Part of the cargo, landed before detection of plague, had passed to consignees and was not interfered with. Part still on the quay was turned over, and new bags were substituted for faulty bags. No aeration or disinfection of bags or grain was done, and distribution of the cargo was not interfered with further. As appears elsewhere, the last plague-rat of this outbreak was taken 15th August, in a far removed lane of the city, to which it could not have reached from the quay at which the "Alsterschwan" lay.

Darling Island (so-called, *see* Diagram), where this vessel lay, is faced with concrete blocks, and comprises an area of several acres which carries many large sheds; it is traversed by many railway lines. Owing to the general construction of these yards, and to the persistent attention of the Railway Commissioners, rats have always been few here. No plague-rat has at any time ever been taken on the Island, and the nearest point at which any have been collected was in Pyrmont, in a street at a considerable distance from it, and on 13th July, 1902. No plague-rats have been observed either at the Island or in Pyrmont during the two years which at this present date have since elapsed.

The only information at command concerning plague at ports of South America touched by the "Alsterschwan" on this voyage is contained in the reports issued by the Public Health and Marine Hospital Service of the United States, from which it appears that eight cases were noted on 14th April at Buenos Ayres, while the s.s. "Duca di Galliera" was reported under date 23rd June to have arrived at Genoa with two cases of plague, and at Barcelona with one case, on board, and in July the s.s. "Espagne" was found on arrival at Marseilles to have plague on board, both vessels having taken their departure from Buenos Ayres.*

The "Alsterschwan" is the second vessel on which plague-rats have been detected in Sydney.

25. The large number of rats and mice caught at Gray's stables, and the length of time during which they continued to be found, have already been referred to above as requiring explanation. The circumstances were as follows:—

GRAY'S STABLES, WATERLOO.

The stables were situated on the margin of a populous neighbourhood, 2 miles from the focus in a direct line, and on a part of an area of blown sand rather sparsely occupied by factories. A varying number of horses were housed there, but usually about 100. The buildings, which comprised stables, sheds

* As regards an earlier date than this see "Sur les épidémies de peste bubonique à l'Assumption (Paraguay) et à Rosario (République Argentine)," par M. Leopoldo Uriarte.—Annales de l'Institut Pasteur, 1901, p. 857.

sheds, feed-stores, and offices, were numerous, and the area occupied by them measured more than 13,000 square feet; they were ill-constructed of wood and iron. They were in a discreditable and filthy state, and greatly infested with rats and mice, to which linings, flooring-planks laid on the sand, and layers of unremoved horse-dung of great thickness afforded harbourage. They were leased to an omnibus proprietor, and were in part sublet to a firm of carriers.

In 1902 a plague-rat was taken on 26th April; and on 11th May one of the average number of forty men employed was attacked with plague. From that date onwards efforts were steadily made to cause the Local Authority to compel the tenants to reconstruct these stables, and to place them in reasonably good sanitary state; but the lease was to expire in a few months, and the granting of a new lease was then delayed by death of the owner. Hence, as the general epizoötic had ceased almost concurrently with cleansing of the premises from infection, a delay was allowed which, as it turned out, became protracted until the further occurrence of plague now being described.

In 1903 the first plague-rat was taken here on 15th June. The premises continued to yield plague-rodents for the next 36 days, a total of 64 infected rats and of 14 infected mice having been gradually collected during that term, notwithstanding that the general cleansing of the place had been completed in about a fortnight. The reason lay in the local conditions. Some of the rodents nested in the cover which was afforded by linings and so-called "floors," or in the sand underneath the latter; these were easily turned out. But the whole area presented burrows at many different points, and especially over a rather large tract of it which, it was found, had at some earlier date been the site of a garbage tip. Hence the search was at once difficult to complete and very laborious; and although the last plague-rodent was discovered on 20th June, the rats infesting the place were by no means then exhausted, but continued to be captured from time to time during several weeks thereafter in which watch was kept upon them.

The manner in which infected carcases made appearance is shown in the following Table:—

Date.	No. examined.		No. infected.		Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.		Rats.	Mice.	Rats.	Mice.
15 June, 1903 ...	12	...	11	...	9 July, 1903 ...	...	2	...	...
16 „ „ ...	6	...	3	...	10 „ „ ...	...	1	...	...
16 „ „ ...	9	1	3	...	13 „ „ ...	...	1	...	...
16 „ „ ...	15	1	12	...	14 „ „ ...	...	1	...	...
17 „ „ ...	1	3	...	...	15 „ „ ...	...	3	...	...
17 „ „ ...	16	6	10	...	16 „ „ ...	...	2	...	1
18 „ „ ...	3	5	1	...	18 „ „ ...	...	2	...	...
18 „ „ ...	17	1	10	1	20 „ „ ...	...	2	...	1
19 „ „ ...	5	...	3	...	21 „ „ ...	...	2	...	...
19 „ „ ...	25	3	10	...	22 „ „ ...	...	1	...	...
20 „ „ ...	3	2	...	...	24 „ „ ...	...	2	...	...
20 „ „ ...	13	4	...	...	30 „ „ ...	2	...	...	...
20 „ „ ...	2	1	...	...	7 August, „ ...	1	1	...	...
22 „ „ ...	7	...	1	...	10 „ „ ...	...	2	...	...
23 „ „ ...	2	...	...	...	11 „ „ ...	1	2	...	...
23 „ „ ...	4	8	...	2	12 „ „ ...	1	1	...	...
24 „ „ ...	2	4	...	3	13 „ „ ...	...	2	...	...
24 „ „ ...	2	1	...	...	14 „ „ ...	...	2	...	...
25 „ „ ...	1	3	...	1	15 „ „ ...	1	1	...	...
26 „ „ ...	...	3	...	1	17 „ „ ...	1	...	...	...
27 „ „ ...	2	1	...	1	18 „ „ ...	1	...	...	...
29 „ „ ...	1	6	...	...	22 „ „ ...	...	1	...	...
30 „ „ ...	2	1	...	1	24 „ „ ...	1	...	...	...
1 July, „ ...	...	6	...	1	26 „ „ ...	2	1	...	...
3 „ „ ...	...	2	...	...	27 „ „ ...	2	...	...	...
4 „ „ ...	...	2	...	...	28 „ „ ...	1	1	...	...
6 „ „ ...	...	2	...	...	31 „ „ ...	2	...	...	...
7 „ „ ...	...	1	...	...					
8 „ „ ...	...	1	...	1	Grand total ...	166	101	64	14

Plague-rats continued to be found during 14 days only; and of 134 carcases submitted during this term only 64, or a minority, were infected. Plague-mice were found during 25 days; but of the 66 submitted only 14 were infected. During forty days subsequent to observation of the last plague-rat, 32 healthy rats were brought in; and during nineteen days after discovery of the last plague-mouse 19 healthy mice were submitted. Rats eat mice as well as each other.

No person took the infection at these stables in 1903. General information furnished by the intelligence staff before 15th June, and concentration of that staff in the neighbourhood subsequent thereto, showed that the latter was free from infection; and there is no room for reasonable doubt that it was conveyed *per saltum* to the stables from the focus at Darling Harbour, although the proprietors could not say more as to origin of their supplies of feed than that they purchased in lots as favourable opportunities offered, and of any dealer in Sussex-street whose terms suited them. However, some slight evidence of its spread to the contiguous land and the buildings on it was gained by discovery of a single plague-rat at a soap-works near the stables on 23rd June, and on inhabited premises in a street at a rather greater distance away (and in another direction) on 24th June; but further search rendered it probable that these animals were but strays, fortunately detected before they had had time to become a source of the disease to any horde which they may have joined. The omnibus service was transferred to other premises; the omnibuses were not interfered with.

After this second outbreak the premises were given up, and new stables were erected elsewhere.

26. Analysis of the records relating to discovery of infected rodents on the 23 remaining premises shows that 15 of them yielded plague-rats on a single day, namely, the day of discovery and of report; 14 of them also yielded but a single specimen. The other, which was a large factory where spices, rice, maize, mustard, &c., were manufactured or packed, yielded 4 on the one day, and no more were found during the several subsequent days over which the search extended. Of these 15 places 6 were wharves or piers, 2 were pieces of vacant land, 2 were streets or lanes. Of the other five, one was another factory for oatmeal, maize, &c., one was a soap-works (Waterloo, see above), and 3 were produce stores on the water side of Sussex-street.

27. The eight places from which plague-rodents were collected on more than one day yielded them during terms which extended to 2, 4, 12, 16, and 52 days. Seven of them were produce stores, situated on the water side of Sussex-street; the eighth was a wharf abutting on that street. The tables which are printed in Appendix A show the dates on which plague rodents made appearance among the healthy carcases. They are not complete as regards the after term, but no more infected carcases were taken. In the lastmentioned case (52 days) a long interval of 47 days, during which 11 plague-free rats and 36 plague-free mice were taken on 14 days, pointed to reinfection of the premises.

28. The two patients were lodged in one half of a small ward in the Infectious Diseases Division of the Coast Hospital, of which the other half continued to be occupied by persons suffering from other forms of disease. The rooms in which they had lain ill at home were disinfected in usual ways as a measure of precaution, although our uniform experience has been that such patients never communicate infection to their surroundings. Contacts were examined and recorded, but were not afterwards interfered with in any way.

29. It will have been perceived that the details mentioned in this account are fuller and still more nearly complete than those which were given in the corresponding histories of the outbreaks of 1900 and 1902, while the former exactness has been maintained. This is to be ascribed in part to the results of teaching and experience on the numerous members of the inferior staff, and, indeed, in some measure on the general public; but little advance in knowledge of many of the phenomena of plague in this city could be made without their intelligent co-operation. But all concerned in practical management have greatly benefited by further reflection and wider experience. Consequently, plans were laid on this last occasion with more assured confidence, directions were given with greater precision, and both were more completely carried out than ever before; while superfluous effort, the cause of unnecessary expenditure, was completely restrained.

J. ASHBURTON THOMPSON.

APPENDIX A.

APPENDIX A.

TABLES showing the way in which Plague rodents appeared among rodents captured on infected premises from which plague-infected rodents were taken on more than one day.

153, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats	Mice.
1903.				
9 May ...	1	...	...	...
11 „ ...	1	...	...	...
12 „ ...	3	...	1	...
13 „ ...	4	11	2	...
14 „ ...	1	...	...	...
16 „ ...	2	...	...	...
Total ...	12	11	3	...

151, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice	Rats.	Mice
1903.				
14 May ...	1	...	...	...
15 „ ...	2	...	2	...
16 „ ...	4	1	2	...
18 „ ...	1	...	...	...
21 „ ...	1	1	...	...
.....	9	2	4	...

139, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 May ...	1	...	...	...
15 „ ...	1	...	1	...
18 „ ...	2	1	...	1
18 „ ...	5	1	...	1
19 „ ...	3	...	...	...
.....	12	2	1	2

129, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
18 May ...	8	4	...	...
19 „ ...	2	1	1	...
18 June ...	...	7	...	...
19 „ ...	...	4	...	...
20 „ ...	1	4	...	...
22 „ ...	2	2	...	...
23 „ ...	...	3	...	...
24 „ ...	...	5	...	...
25 „ ...	...	3	...	...
26 „ ...	...	2	...	...
27 „ ...	...	1	...	...
29 „ ...	1	...	...	...
30 „ ...	...	1	...	...
1 July ...	2	1	...	...
2 „ ...	1	...	...	...
4 „ ...	4	3	...	...
6 „ ...	...	1	...	1
7 „ ...	...	1	...	1
9 „ ...	3	10	1	5
10 „ ...	...	4	...	...
13 „ ...	...	1	...	...
17 August ...	...	2	...	...
18 „ ...	...	1	...	...
19 „ ...	...	1	...	...
21 „ ...	...	1	...	...
22 „ ...	2	1	...	...
24 „ ...	...	1	...	...
25 „ ...	...	1	...	...
.....	26	66	2	7

101, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
21 May ...	1	2	...	...
21 „ ...	...	1	...	1
22 „ ...	Cat. 1	1	...	1
22 „ ...	Rats. 1	...	...	...
23 „ ...	1	4	...	1
25 „ ...	...	3	...	2
26 „ ...	1	4	...	1
26 „ ...	...	4	...	1
27 „ ...	...	3	...	2
27 „ ...	...	8	...	...
28 „ ...	...	4	...	1
29 „ ...	...	7	...	2
30 „ ...	...	16	...	...
1 June ...	...	8	...	...
1 „ ...	...	4	...	1
22 „ ...	...	2	...	...
.....	5	71	...	13

137, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 May ...	10	5	...	...
18 „ ...	1	17	...	...
18 „ ...	23	4	...	...
18 „ ...	8	20	...	...
18 „ ...	15	6	...	...
19 „ ...	1	1	...	...
20 „ ...	9	...	...	...
25 „ ...	...	1	...	...
26 „ ...	1	...	...	...
27 „ ...	1	...	...	...
5 June ...	3	1	...	...
6 „ ...	3	1	...	...
9 „ ...	2	...	...	...
10 „ ...	1	1	1	...
11 „ ...	1	...	...	...
15 „ ...	1	...	1	...
15 „ ...	15	7	2	...
16 „ ...	1	1	1	...
16 „ ...	7	4	6	...
17 „ ...	9	2	2	...
17 „ ...	3	3	...	...
18 „ ...	5	3	2	...
25 „ ...	...	2	...	1
29 „ ...	1	...	...	...
1 July ...	1	...	...	...
25 „ ...	...	7	...	...
.....	122	86	15	1

123, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
16 May ...	2	...	...	...
19 „ ...	2	1	...	...
22 „ ...	2	...	...	...
23 „ ...	1	5	...	...
12 June ...	...	3	...	...
6 July ...	1	1	...	1
7 „ ...	1	2	...	2
8 „ ...	1	18	...	...
9 „ ...	...	2	...	...
.....	10	32	...	3

Huddart Parker's Wharf, Margaret-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
6 Aug. ...	4	5	1	...
11 „ ...	...	2	...	1
.....	4	7	1	1

APPENDIX B.

APPENDIX B.

[Form No. 312.]

DEPARTMENT OF PUBLIC HEALTH, NEW SOUTH WALES.

"MUNICIPALITIES ACT, 1897."

MODEL By-laws under section 130 (xxii) for better prevention of the spread of Plague by Rats; for regulating the construction and maintenance of Stables, Produce Stores, &c., &c.; and for storage and collection of House Refuse and Garbage.

(As passed by the Attorney General, 2nd July, 1903.)

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1. The owner of any produce store in the Municipality, the floors of which are of such material, or so constructed, or in such a state as to permit the harbouring of rats in or about such store, shall, within one month after service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such floors to be so reconstructed of concrete, stone, or other material impervious to rats, and shall so repair, alter, reconstruct or protect skirting-boards, partitions, doors, ventilation or other openings in the walls or elsewhere of such produce store, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about it.

2. The owner of any premises within the Municipality who, after the passing of these by-laws, shall construct or let any building therein for the purposes of a produce store, or who shall convert any building therein to the purposes of a produce store, shall upon such construction, letting, or conversion, as the case may be, cause the floors thereof to be constructed of concrete, stone, or of other material impervious to rats, and he shall so construct, alter, repair, reconstruct or protect skirting-boards, partitions, doors, ventilation or other openings in the walls or elsewhere, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about such premises.

3. The owner of any building, other than a produce store in the Municipality, which is in such a condition as to permit the access of rats to, or the harbourage of rats in it, and whether such condition be in the structure, or in openings in it, or in doors or ways of entrance to it, or in its floors, skirting-boards, ceilings, partitions, or the like internal fittings within it, shall, within one month after service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such building to be so repaired, or as regards its doors or ways of entrance and its floors, skirting-boards ceilings, partitions, and the like internal fittings within it, to be so altered or repaired, as to prevent, as far as practicable, access of rats to it and harbourage of rats within it.

4. The owner of any premises within the Municipality with which is connected any area grating, or in the external walls of which is any other opening of such a nature as to permit the entry of rats thereto, shall, within fourteen days of service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such area grating and such other openings to be covered with wire netting of such a mesh and in such a manner as to prevent the entry of rats through them.

5. The owner of any stable, cow-yard, or cattle-shed, within the Municipality now constructed, shall cause the same to be paved, flagged or floored with concrete, stone, or other material impervious to rats, and to be completely and well drained, and to have proper sewer connections where available, within one month after service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do.

6. The occupier of such premises shall, upon production of the notice served upon the owner as aforesaid, allow the owner and his workmen free access thereto for the purpose of enabling him and them to comply with the terms of the preceding by-laws.

7. The owner of any premises within the Municipality who shall, after the passing of these by-laws, construct a stable, cow-yard, cattle-shed, or pig-sty therein, or convert any building therein into a stable, cow-yard, cattle-shed, or pig-sty, shall cause the same to be paved, flagged, or floored with concrete or stone, or other approved material impervious to rats, to be completely and well drained, and to have proper sewer connections where available.

8. The owner or occupier of any stable, cow-yard, cattle-shed, or pig-sty within the Municipality shall, within one month of service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause any feed-store connected with such stable, cow-yard, cattle-shed, or pig-sty to be floored with concrete, stone, or other material impervious to rats, and shall so reconstruct, repair, or alter any floor, wall, and any ceiling or partition within it as may be directed so as to prevent the harbourage of rats therein, and shall protect all openings in the external walls thereof as may be directed so as to prevent the access of rats thereto.

9. The occupier of any premises in the Municipality which contain any stable, cow-yard, cattle-shed or pig-sty shall provide a bin for the reception of all dung or refuse arising in such stable, cow-yard, cattle-shed, or pig-sty, and shall cause such stable, cow-yard, cattle-shed, or pig-sty to be cleansed daily; and all manure, dung or other refuse arising in or in connection therewith if not removed from the premises immediately to be placed in such bin, and shall cause the said bin to be kept covered, and to be emptied and cleansed and its contents to be removed from the premises at least once in every week, and shall not at any time allow such bin to be or to remain a nuisance.

10. No person shall place or throw or suffer to remain any refuse on any premises in the Municipality in such a manner or for such a time as to encourage rats or other vermin to visit or frequent such premises.

11. Every occupier of premises in the Municipality shall, within seven days of service upon him of a notice purporting to be signed by the Inspector of Nuisances for the Municipality requiring him so to do, provide a sufficient number of receptacles of rigid metal, cylindrical in shape, and each of a capacity not exceeding 2 cubic feet for the reception of the garbage and refuse arising upon such premises.

12. Every such occupier shall provide all refuse and garbage receptacles in use on such premises with a cover, fitting as closely as practicable, and shall cause such receptacles to be continuously covered, save when garbage or refuse is being deposited in or discharged from them.

13. Every such occupier shall cause all refuse or garbage receptacles in use on his premises and the covers thereof to be kept as clean as practicable, and maintained in good order and condition, and shall cause all garbage and refuse from time to time arising upon such premises to be forthwith deposited in such receptacles.

14. Every such occupier between such hours and on such days as may be prescribed by notice served upon him, and purporting to be signed by the Inspector of Nuisances, shall cause such receptacles to be placed in such a position on such premises as to be within 6 feet of the gateway or entrance from the street abutting on such premises, which is traversed by any vehicle employed by the Council in the collection of garbage and refuse, and so as to be conveniently accessible to the persons employed by the Council in the removal of garbage and refuse. Provided that if, by reason of conformation of the premises, it shall not be practicable to comply with the requirements of this by-law, and such occupier shall cause such receptacles to be placed on the outer edge of the footway in such street between the hours and days as aforesaid, he shall not be guilty of an offence against this by-law.

15. No person other than a workman employed by the Council in the collection of garbage and in street-cleansing shall interfere with, disturb, or remove any garbage receptacle for the time being in any street, nor the contents of any such receptacle.

16. The owner of any premises within the Municipality shall, within one month of service of a written notice purporting to be signed by the Inspector of Nuisances, cause the floor of any water-closet and of any pail-closet situated wholly or in part outside the walls of the dwelling portion of the premises, to be constructed of good cement concrete not less than four inches in thickness, and to be so laid that it shall be in every part thereof at a height of not less than six inches above the level of the ground adjoining such closet, and so that the said floor may have a fall or inclination from the rear of the closet towards the door of entrance of not less than one-half inch to the foot, and the riser enclosing the space beneath the seat (if any) to be removed in the case of a water-closet, and in the case of a pail-closet to be well fitted to the seat and to extend downwards not more than four inches from the under side of the seat.

17. In construction of these by-laws the words "produce store" shall mean any building or portion of a building wherein wheat, oats, barley, maize, pollard, bran, hay, lucerne, or chaff is deposited or exposed for sale, and with regard to other words, a similar construction shall be applied as the Interpretation Act, No. 4, 1897, provides for the interpretation of Acts of Parliament.

18. Any person offending against any of the above by-laws shall for each offence, upon conviction, forfeit and pay a sum not exceeding £10.

By order,
G. H. KING,
Secretary.

Sydney, 22nd July, 1903.

In the Metropolitan District the following Municipal Councils voluntarily adopted these by-laws:—

Alexandria.	Enfield.	Parramatta.
Annandale.	Granville.	Petersham.
Ashfield.	Hurstville.	Randwick.
Balmain.	Leichhardt.	Rockdale.
Burwood.	Manly.	Vaucluse.
Canterbury.	Mosman.	Waterloo.
Concord.	North Sydney.	Willoughby.

The by-laws were ultimately imposed (see Public Health Act, section 25) on the following:—

Bankstown.	Hunter's Hill.	Redfern.
Botany.	Kogarah.	Rookwood.
Camperdown.	Lane Cove.	Ryde.
Darlington.	Marrickville.	St. Peters.
Drummoyne.	Marsfield.	Strathfield.
Ermington and Rydalmere.	Newtown.	Waverley.
Erskineville.	North Botany.	Woollahra.
Glebe.	Paddington.	

[Diagram.]

Sydney: William Applegate Gullick, Government Printer.—1904.

PLAGUE REPORT 1903.

Table shewing the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken. References to the two cases are inserted in the series in their order according to the date of attack, and these are not numbered.

№	Place	Plague Rodents Taken W.Dec.	W.Rat	W.Mus	Total	First date	Last date
1	103 Sussex Street	3			3	12.5.03	13.5.03
2	107 Sussex Street	4			4	15.5.03	16.5.03
3	109 Sussex Street	1		2	3	15.5.03	18.5.03
4	109 Sussex Street	1	1	7	9	19.5.03	19.5.03
5	Dangar Gedye's Wharf, № 1, Woo	1			1	20.5.03	20.5.03
6	101 Sussex Street			14	14	21.5.03	1.6.03
7	98 Sussex Street			1	1	22.5.03	22.5.03
8	Long Pier, Woolloomooloo	1			1	28.5.03	28.5.03
9	137 Sussex Street	2	13	1	16	30.5.03	25.6.03
10	A.U.S.N. Wharf, № 1	1			1	13.6.03	13.6.03
11	Gregs Stables, Elizabeth Street, Waterloo	64		14	78	15.6.03	30.7.03
12	Towns Wharf	1			1	15.6.03	15.6.03
13	Gadjerya. Wharf, New, № 1	1			1	15.6.03	15.6.03
	Case A, attacked 17.6.03						
14	268 Kent Street			1	1	22.6.03	22.6.03
15	Hunters Soap Works, Bourke Street, Waterloo	1			1	23.6.03	23.6.03
16	161 Pitt Street, Waterloo	1			1	24.6.03	24.6.03
	Case B, attacked 2.7.03						
17	101 Sussex Street			3	3	6.7.03	7.7.03
18	195 Sussex Street			1	1	6.7.03	6.7.03
19	259 Sussex Street	1			1	9.7.03	9.7.03
20	Record Lane, Off Lime Street	1			1	11.7.03	11.7.03
21	329 Kent Street			4	4	14.7.03	14.7.03
22	W. Flanders Point, Potts Point	1			1	15.7.03	15.7.03
23	H. Parkers Wharf, Margaret Street		1	1	2	6.8.03	11.8.03
24	Ship Knorrenheim, Darling Island		11		11	7.8.03	11.8.03
25	Loftus Lane, Off Loftus Street	1			1	15.8.03	15.8.03
	Totals	86	26	49	161		

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHEWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1903, THE PLACES AT WHICH TWO PERSONS WHO HAD PLAGUE WERE EMPLOYED AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place ... shown thus ●22

Places at which 2 persons who had plague were employed ... do. A.B.

Do. do. do. resided ... do. (A)(B)

Boundaries of the Wards into which the City proper is divided ...

J. Cumberbatch Thompson. 7th Dec: 1903.


10 MAY 1928

1905.

LEGISLATIVE ASSEMBLY.

NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

FOURTH OUTBREAK OF PLAGUE AT SYDNEY, 1904;

With Remarks on the Aetiology of Plague, based on its observed Epidemiology, 1900-4.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President
Chief Medical Officer of the Government.

Printed under No. 7 Report from Printing Committee, 17 August, 1905.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1905.

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By J. ASHBURTON THOMPSON, M.D., D.P.H., President, Chief Medical Officer of the Government.

---

7 July, 1905.

ALTHOUGH it has been stated in each of the reports for 1900, 1902, and 1903, that, at Sydney, man has acquired the infection of plague from rats affected with that disease, the remark is here made once more in connection with further precise evidence now to be adduced. Epidemic plague at Sydney has always depended wholly and solely on epizoötic plague; and it has been successfully controlled there by measures directed, not at man, nor at the filth in which he sometimes lives, but at the rat alone. The manner in which the infection is communicated from rat to man is a subject of great practical importance; but it may, and in my opinion should, be separately examined. The hypothesis of the flea, notwithstanding much circumstantial evidence adduced first in this series of papers, has remained thus far insufficiently examined by direct experiment.

2. The plague-rat is the source of infection for man; to get rid of it is to stay the disease. The ground for that opinion has been described in detail in the three previous accounts, and with completeness; but it is possible that it has not appeared to be perfectly sound to some who may not have found themselves at liberty to examine it very closely. Should this have been so, some circumstances which may have been contributory to their doubt can be mentioned. Thus, the first report (November, 1900) was necessarily occupied in the main with examination of the commonly received view that plague becomes epidemic as the result of direct or indirect communication with the sick. On this point attention was at that time concentrated, for until the ground had been cleared by settling it conclusively nothing further could be done; and consequently, although the influence of plague-rats was watched at the same time, and so watched as to warrant those who actually observed the course of events in ascribing the principal rôle to them, evidence sufficient to establish this to the satisfaction of others was not then obtained. The inefficiency of that cause having been decisively established by the course of the epidemic of 1900, in 1902 the rôle of the rat preoccupied attention. It was so examined, and the results were so recorded in the report which related to that year, as to show its preponderating and, indeed, its exclusive importance. Still, the evidence, though full and cogent, was hardly of the kind which he who runs may read. I point out, therefore, as a second contributory circumstance, that reasonings in which defects in the evidence are given almost equal prominence with ascertained data are likely to confuse all but the critical reader; and this is the character which the preceding descriptions of plague at Sydney have had, for my object has been to draw a complete picture of all the known circumstances—a character which has not been so commonly shared by writings on the epidemiology of plague as to make reference to it in this place superfluous.

3. By 1903 the exclusive nature of the rôle played by the rat had come to be generally accepted by all in this State. We had not merely learned that but one thing was necessary to stay, and to prevent, epidemic plague, namely, to kill the plague-rat

plague-rat, but also that the plague-rat could be searched out with sufficient completeness, difficult or even hopeless as this business may have seemed at first sight. Instructions, consequently, were simplified to the last degree. The business of getting them punctually observed, also, was facilitated by the thorough training which the staff had by that time received, and by the active and intelligent assistance which the public had been gradually brought to render willingly, even when it happened that their action was attended with expense to them, and with some less direct injury to their immediate personal interests. Leisure to inquire into the circumstances of each case, and into the condition of each building and neighbourhood, in the most complete and exact way thus became available, and for the first time it was possible to concentrate attention on an attempt to learn whether very close association with plague-rats could not be established in every case of plague, provided sufficient time were devoted to the investigation. But evidently the method of managing epidemic plague which had been adopted was inimical to this object, for just in as far as it was well grounded and thoroughly applied it was likely to prevent cases from occurring. In point of fact, it turned out in 1903 that although the epizoötic did smoulder for about three and a half months in spite of all that was done to extinguish it, it was so far successfully restricted by the method referred to that it never attained to considerable dimensions in any neighbourhood, and consequently gave rise only to two cases. That the completeness of this result was in part due to some favouring circumstance which has not been precisely identified is likely enough ; but, however that may be, two cases were insufficient for the purposes of the contemplated inquiry, and another opportunity was awaited. It arrived during the year under review, and it was utilised as described below. It will be found that the connection mentioned above between plague-rats and man was established in every instance.

4. The last evidence of presence of plague in Sydney connected with the preceding outbreak was got on 15th August, 1903, when the infection was identified in the carcase of a rat. The outbreak now to be described consisted in an epizoötic of plague of which the first direct evidence was got on 1st March, 1904, the last on 3rd December; thus it continued during 9 months. Its course was marked by occurrence of plague in 12 persons who inhabited 11 dwellings, of whom 6 died; the first case was notified 9th March, the last on 10th September, 1904, and these dates defined a period of a little over 6 months which fell within the time-limits of the epizoötic.

5. The term which it is necessary to review comprised rather more than 13 months, and may be divided as follows. The precedent plague-free period dated from 16th August, 1903, to 29th February, 1904; the epizoötic period from 1st March to 3rd December ; and the ensuing plague-free period from 4th to 31st December, 1904. It is as well to mention here that the latter turned out to be very short, but that recommencement of the epizoötic at Sydney (19th January, 1905, at the North Coast S.S. Company's Wharf) was thought to have resulted from reintroduction of the infection from a district on the northern coast-line of the State, which itself was probably infected by sea from another source than Sydney.

6. The way in which watch was kept on the state of the rat tribe during the three periods just mentioned, and in which the epizoötic was restricted during the second of them, were precisely the same as has already been described in detail (Report, 1903) ; the officers concerned were the same, they performed similar functions, and the result of the general operations was marked by a success which was as nearly the same as could be expected. Description of these details for 1904 would entail useless repetition and is omitted.

7. Now, as regards the precedent plague-free period, which dated from 16th August, 1903, to 29th February, 1904, the number of rats destroyed was 53,912, of mice, 24,249; total rodents destroyed, 78,161. Of these the public delivered 41,982 rats and 17,723 mice, total 59,705, for which they were paid. None of these were examined in the laboratory, for reasons already explained (Report, 1903, par. 7). The remainder were collected by the intelligence staff, namely, 11,930 rats and 6,526 mice; total, 18,456. All of these were examined in the laboratory (at the rate, therefore, of about 110 a day), and all were found to be free from infection with plague. They had been collected on the wharf-line, which extended from the head of Darling Harbour to the eastern head of Woolloomooloo Bay, from stores and buildings

buildings connected with it, and from some closely adjacent streets of the city, being localities in which experience had shown that recurrent plague was most likely first to show itself. Thus, on 28th February, 1904, it appeared probable that Sydney had been free from plague in its rats for more than six months, as it certainly had been free from plague in man.

8. During the second, or epizoötic, period which dated from 1st March to 3rd December, 1904, the number of rats destroyed was 61,657, of mice, 47,279; total, 108,936. Of these, 41,263 rats and 23,851 mice, total 65,114, were brought in by the public, and were paid for as above-mentioned. None of them were examined. The intelligence staff delivered 20,394 rats and 23,428 mice (total, 43,822), all of which were examined at the laboratory, at the rate of about 182 a day. Among them, 181 rats and 62 mice, total 243, were found to have had plague; the remainder were free from this infection. Additionally, 13 other animals were referred for examination, namely, 5 domestic cats, 1 opossum, 5 native-cats (*Dasyurus viverinus*, Shaw), 1 tiger-cat (*Dasyurus maculatus*, Kerr), and 1 sparrow (*Passer domesticus*). Plague was identified in 1 domestic cat, and this was the second in which this infection had been observed at Sydney (*see* Report, 1900, p. 39).

Besides the above-mentioned animals, the infection of plague has been identified at Sydney by Tidswell in the following, which had become exposed to it in a zoological garden :—4 wallabies, 1 wallaroo, 1 pademelon, and 1 tree-kangaroo (all of which are marsupials), in 1 Indian antelope, and in 3 caged guinea-pigs. As plague had not previously been observed in marsupials, the methods employed to discover and to discriminate the bacillus were of the highest importance; they were, therefore, described at length (Report, 1902, parts 157-163), although they differed not at all from those usually followed in this laboratory in connection with plague-work in general.

No other animals, and especially none of the farm-yard species, have fallen under suspicion of infection in this part of the world. Simpson and Hunter, working at Hongkong, have reported that various domestic animals (pigs, calves, fowls, turkeys, geese, ducks, pigeons, &c.) were infected experimentally by them, and that the pigs often survived for more than a month, during which they offered no evident sign of illness except an increased body temperature, although they died of plague at last. (Simpson : "Report to the Secretary of State for the Colonies on Plague at Hongkong," 1903, pp. 49-103.) The evidence adduced by the authors in support of their conclusions was meagre. Bacteriological methods and results, and the experimental conditions in general, were not adequately described, so that their statements amounted to little more than assertions, notwithstanding clinical accounts of the cases. Confirmation must, therefore, be awaited.

These experiments were repeated in Natal by Mr. H. Watkins-Pitchford, F.R.C.V.S., Government Bacteriologist, who reported upon them, and Dr. Haydon. ("Report on the Plague in Natal, 1902-3; by Ernest Hill, M.R.C.S., D.P.H., Health Officer for the Colony." Cassell & Co., London, 1904). The series of animals employed comprised 20 barn-yard fowls, 11 pigs, and 2 calves. The results were uniformly negative; plague was not communicated in any instance. The details were so completely given by Mr. Pitchford that little was left wanting.

9. During the third, or ensuing plague-free period, which dated from 4th December to 31st December, 1904, 5,435 rats and 2,796 mice, total 8,231, were destroyed. Of these, 3,504 rats, and 1,582 mice, total 5,086, were brought in by the public, and none of them were examined. The intelligence staff delivered 1,931 rats and 1,214 mice, total 3,145, all of which were examined at the laboratory, and all were found to be free from infection with plague.

10. The several species of rodents examined in the laboratory during the whole of the year 1904, and the proportions in which they occurred, can be stated. The total number was 52,014; 35·43 per cent. of them were *Mus decumanus*, 14·06 per cent. were *Mus rattus*, and 50·47 per cent. were *Mus musculus*.

11. The number examined during the epizoötic period alone was 43,822; 32·15 per cent. of them were *Mus decumanus*, 14·36 per cent. were *Mus rattus*, and 53·44 per cent. were *Mus musculus*.

12. Of those which were found to be infected with plague, 108 were *Mus decumanus*, 73 *Mus rattus*, and 62 *Mus musculus*, and these constituted respectively 44·26 per cent., 29·92 per cent., and 25·41 per cent., of the total (243) infected.

13. The percentage of each species infected to the total of each species examined during the epizoötic period was for *Mus decumanus* ·76, for *Mus rattus* 1·16, and for *Mus musculus* ·26; or, for all rats ·9, and for mice but ·26, although the number of mice examined (23,428) exceeded the number of both species of rats taken together (20,394.) As all these rodents were collected by the same staff, working on the same areas, perhaps some reason appears for supposing that mice may be less susceptible than rats to "natural," as they are to laboratory, plague. In connection with the small proportion of the infected to the total rodents examined during this period, remarks already made (Report, 1903, pars. 13 to 15) should be reperused.

14. The species of rodents found on the nine premises at which the twelve patients were adjudged to have received the infection were as follows:—Case A, *Mus musculus* (but rats had died in unusual number before notification of the case, and on search some carcases were found at a stage of putrefaction which was too far advanced for bacteriological examination); Case C, *M. decumanus*; Case I, *M. musculus* and *M. decumanus*; Cases B, E, and G, *M. musculus, decumanus,* and *rattus*; Cases, D, F, H, K, L, and M, *M. musculus* and *rattus*—in other words, *M. musculus* was found alone at one place of infection, *M. decumanus* alone at a second, *M. musculus* and *decumanus* at a third, *M. musculus, decumanus,* and *rattus* together at a fourth and fifth, and *M. musculus* with *rattus* at the remaining four. It should be borne in mind that these figures are not conclusive; they represent merely what happened to be discovered, and in reality show only that all three species suffer from plague, and have been found in association with cases in man. That *M. decumanus* alone may be an adequate cause of plague in man, however, was shown in the case of the s.s. "Antillean" (Report, 1902, pars. 50–65), and has recently further appeared from an outbreak in a distant part of the State, which will be made the subject of a separate report. In a farming district on a river about 300 miles north of Sydney, 12 cases, of which 7 were fatal, occurred in 10 houses. Considerable numbers of infected rats were collected, all of which were *M. decumanus*. Large numbers of uninfected rats were also examined, among which only a half-dozen or so of *M. rattus* were found.

15. The kinds of fleas found on the different species of rats caught at Sydney were determined by the Microbiologist (Dr. Frank Tidswell, M.B., D.P.H.), who has furnished the following statement (see also Reports, 1900, pp. 40, 56, and 57; and 1902, pars. 272 to 292):—

As opportunity offered during the year, individual species of rodents were searched for fleas. Such opportunities were not particularly frequent, as most often different species were put together in the same parcel, so that fleas from one might easily have become transferred to another. Collections were only attempted when the animals submitted were all of one species. The opportunities were still further narrowed down by the fact that often no fleas were obtained under these circumstances. However, the results of this part of the work were as follow:—

TABLE I.—1904.

Species of Fleas.	*M. Decumanus.*	*M. Rattus.*	*M. Masculus.*	Total.
Ceratophyllus (pulex) fasciatus...	1	3	6	10
Ctenopsylla (typhlopsylla) musculi	9	5	17	31
Pulex pallidus (cheopis, Rothsch)	76	5	12	93

F. T.

16. The 243 infected rodents were taken on 41 different premises between 1st March and 3rd December, but the last was taken on premises which had become infected much earlier. Freshly infected premises continued to be discovered only down to the 10th October. Further, although the first rodent in which plague was identified was collected by the intelligence staff on 1st March at Grafton Wharf (see Diagram, No. 1), unusual mortality among rats at 157, Sussex-street, on and after 29th February, was reported (see Diagram, No. 2). There plague was identified in two mice collected on 11th March, or the day after Case A (see below) had been notified in connection with those premises; it is probable, therefore, that the epizoötic began in that immediate neighbourhood, if not in that house. Although this would accord with previous experience, which has been that epizoötic plague has always first shown itself at some point of the line of wharves situated on the eastern shore of Darling Harbour, and in 1903 was first observed at the same part of this line (namely, at 153, Sussex-street*), yet I do not consider that the infection was thereby shown to have persisted from year to year. In the first place, while the line referred to included all the wharves at which the produce trade with other States was carried on, hay and chaff with us have been by far the most important kinds of merchandise in relation to risk of importation of plague; thus they were especially liable to reinfection. Secondly, although very many distinct areas have yielded plague-rats in number in the past during some one determinate period, no evidence of persistence of infection on any of them has ever been got. There has been, indeed, a single apparent exception;

* The odd numbers are all on the water side of this street.

exception; but this was Gray's stables, Waterloo (see Report, 1903, par. 25), and a similar explanation applied to it. About 100 horses were stabled there; the necessarily large and frequent supplies of fodder required for them were purchased in Sussex-street, and the infection did not reappear at the stables until long after the epizoötic of that year had declared itself in Sussex-street. All evidence has gone directly against such persistence, and against the view that plague is "a disease of locality" in that sense (*see* also pars. 40–1 below). The infection is "localised" in the rat. But I have not been able to see in the facts observed at Sydney evidence that it can persist in the rat in a chronic form which might serve as the starting point of a fresh and virulent outbreak, nor, in Dr. Tidswell's opinion, has a prolonged and carefully observed laboratory experience furnished any.

17. Of the 41 premises which yielded plague-rodents, 2 only were in private occupation. One of these stood next to a builder's yard, distant from the centre (see Diagram No. 14), where there was a small stable, which was also (probably first) infected, and from which rats could easily pass to it; no doubt the same horde infested both properties. Infection was carried to stables at the other private house *per saltum* from the Darling Harbour centre (see Cases L and M below). Fifteen of the remainder were classed as produce stores, 13 having been of that description, while 1 was a grist-mill and 1 a seedsman's; 12 of these stood on the water-side of Sussex-street. Other 14 were classed as wharves, and stores connected with wharves, 1 of them actually having been a small steamer lying alongside a wharf, and most probably infected from it. Then 2 others were timber-yards having water-frontage, 1 a builder's yard (mentioned above), 1 a distant paper-mill, 1 a general carrier's, 1 a wool-store, 1 a slop shop, 1 a show-room in an arcade, 1 the extensive basement beneath the same arcade, and 1 a public house. The infected cat came from another public house (making 42 places altogether) which yielded no rats. So that plague-rats were found only at places commonly infested with rats, with a few exceptions; and in some of those exceptions merchandise was known to have been imported to them from infected premises.

18. The position of the above-mentioned places is shown on the accompanying Diagram by spots which have been numbered consecutively in the order of date on which a plague-infected rodent was first observed at each of them; and in a table printed on the Diagram the addresses of the places are given. These have been consecutively numbered to agree with the numbers attached to the spots, and against each is mentioned, not only the first date on which a plague-infected animal was found at it, but also the last date. These two dates do not in all cases represent a continuous infection, and probably have resulted sometimes from reinvasion. By comparison of the numbers and dates thus given, with assistance of the Diagram itself, it is possible to follow the apparent course of the epizoötic; but close acquaintance with local conditions, which cannot profitably be made the subject of a description, is necessary to avoid error. Further reference to this part of the subject, therefore, is not made.

19. The 12 cases of plague in man, which were met with in the course of the epizoötic, were notified from 11 dwellings. Nine of the patients were adjudged to have been infected at their places of employment, the other 3 at their dwellings; but 1 of the latter was also employed away from home. Ten places of employment are therefore shown on the Diagram by the capital letters "A," "B," &c.; and 11 dwellings by the corresponding lower-case letters enclosed within a circle. Some houses in both of these classes stood on areas which did not fall within the limits of the Diagram, but a marginal note sufficiently indicates their situation. The number of adjudged places of infection was but 9, 3 cases having been associated in place with three of the others.

20. The circumstances under which the 12 patients received the infection were as follows. It will be observed that the clinical diagnosis was corroborated by the Microbiologist in every case by microscopical and cultural examinations, and that in some of them the test by inoculation was also employed :—

CASE A.

Summary.—O.G., m., aet. 15, unmarried, errand-boy. No former attack; not inoculated; had had no communication with any previous case, nor with any sick person during 10 days before attack at least. Residence, 7, Isabella-street, Balmain, a suburb about 2 miles (in a straight line and across water) north-westerly from his place of employment, which was at 157, Sussex-street, a produce store. Notified by Dr. Shirlow, 10th March, 1 p.m.; visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Balmain, 2 p.m.; admitted to hospital 10th March, discharged 21st April; duration of illness, 44 days. Right femoral bubo; morphological, cultural, and inoculation tests positive.

Movements

Movements prior to Attack.—For 10 days prior to attack had moved only between his residence and his employment by ferry; his duty required him to visit the North Coast wharf (at the back of his place of employment) every day, and a Newcastle wharf near by once a week. He took his lunch with him, and ate it at the store.

History of Illness.—Rose in usual health 9th March; went to work; at 9 a.m. was suddenly seized with shivering, nausea, general pains, and a sharp pain in the right groin; lay down, eat no lunch, but did not go home till 6 p.m. Became delirious during the night. At 2 p.m., 10th March, the bubo was of the size of a small marble; there was a little periadenitic effusion. Said he had lately caught several fleas on his legs and body, and had killed them; the premises (employment) were infested with fleas; there were traces of numerous flea-bites on legs and abdomen; no other lesions.

Residence.—Weatherboard cottage, semi-detached, one storey, three rooms; repair and cleanliness, fair; no trade-use; no stable near. Connected with sewers. General sanitary state, fair. Bedroom disinfected 11th March.

Employment.—Stone, good repair; used as a produce store. One floor, concrete covered with hard-wood planks in close contact; clean; lighting, fair; ventilation poor. Searched and cleansed 11th March; no goods destroyed.

Rats.—At residence: occupants and neighbours said none had been seen in that neighbourhood for about four years; there were no signs of infestation. At employment: 29th February patient noticed a bad smell, and after search discovered 2 dead rats in the store; on 1st, 2nd, and 3rd March, he found 1, 2, and 2 dead rats; he lifted all of them with a board, and put them in the street gutter. Cleansing staff discovered 7 more carcases on 11th March, 5 (rats) advanced in decomposition; in the other 2 (mice) plague was identified. As regards the immediate neighbourhood, one *Mus rattus*, sick, had been killed 9th March on the roof of 161, Sussex-street (next door but one to No. 157), by a man sent by the Harbour Trust to do repairs; it was delivered at the laboratory where plague was identified in it, morphological, cultural, and inoculation tests having yielded positive results.

Contacts and further Cases.—At residence, 6; at employment, not noted. No further cases.

CASE B.

Summary.—R.W.W., m., aet., 23, married, labourer. No former attack; inoculated at Sydney, 1900; had had no communication with any previous case. Residence, Underwood-street, Paddington, about 2 miles south-easterly from his place of employment, which was at the Grafton Bond, Darling Harbour (northerly end of Sussex-street). Notified by Dr. O'Gorman Hughes, 13th April, midday; visited by the Assistant Medical Officer of the Government, at Underwood-street, 3·15 p.m.; admitted to hospital 13th April, discharged 17th May. Duration of illness, 38 days. Right femoral bubo; morphological, cultural, and inoculation tests, positive.

Movements prior to Attack.—Regularly employed for many weeks at Grafton Bond G, to which a wharf was attached, and which contained cased goods, spirits, drapery, &c.; was entirely employed within the bond; went to work by tram, left at 5·45 and usually went straight home; on 10th April (Sunday) went to Coogee; had not seen any rats at the bond for 14 days past. Took his lunch to the bond, and ate it there. Employers said that although he worked well enough during the day, he drank, and his home was miserably poor.

History of Illness.—10th April, afternoon, while amusing himself at Coogee felt pain in right groin; no headache, &c. 11th, went to work; about midday headache and malaise set in, with increased pain in groin where he then found a lump about the size of a marble; slept little that night. 12th April, went to work again at the usual time; headache, vomiting on rising, and fever; was unable to continue after midday, and returned home. 13th April, at 2·30 p.m., two or three right femoral glands were found enlarged, not very tender, the largest the size of a marble; T. 99·2, P. 105, pale, not apparently very ill. On the right leg were one or two scratches made by finger-nails, no other lesions; no flea-bites visible (the skin was very dirty).

Residence.—Terrace house, 3-storeys, 6 rooms, brick; connected with sewers; cleanliness and general sanitary state, fair, except a basement which dirty and damp. Patient, wife, and infant occupied one room, almost destitute of furniture; bedding burnt because filthy. Room disinfected 14th April. No trade use; no near stable, &c.

Employment.—A new building, sound in all respects; basement floor concrete, other floors not ceiled. Searched as far as possible 13th April.

Rats.—At residence, no signs of infestation; tenants said none seen. At employment, a little rat-dung was found in a few places, no carcases. 1st March, plague was identified in the carcase of a mouse taken at Grafton Bond in a building in which the patient worked when he was not wanted at the building to which he was more especially attached (Bond G); and on 27th April, 14th and 31st May other plague rodents which had been taken at different parts of the collection of buildings which constituted Grafton Bond, were detected among a total of 796 rodents submitted on 81 days between 24th February and 31st May. On 14th, 18th, and 20th April, 3 plague-rats were taken at Adelaide Wharf No. 1 (otherwise called Grafton Wharf), which lay within 50 yards of the bond.

Contacts and further Cases.—At residence and at employment, not noted. No further cases occurred.

CASE C.

Summary.—H.M., m., aet. 36, married, a seedsman. No former attack; not inoculated; no communication with any previous case. Residence, Morgan-street, Marrickville, about 3½ miles south-west from his place of employment, which was at the corner of Pitt and Campbell streets, where he had his shop. Notified by Dr. G. H. Abbott, 22nd April, 10 p.m.; visited by the Assistant Medical Officer of the Government at Marrickville, 23rd April, 10 a.m.; admitted to hospital 23rd April, 3 p.m.; discharged 1st June; duration of illness, 43 days. Right femoral bubo (later a right inguinal gland became enlarged); morphological, cultural, and inoculation tests positive.

Movements prior to attack.—H.M. occupied a retail shop at the corner of Campbell and Pitt streets. In Belmore Market (vegetables, seeds, produce, &c.) across Campbell-street, he had a small bulk store, an apartment built of and floored with wood within the stone-paved market, with a frontage to the eastern end of the latter. Spent most of his time at his retail shop, but canvassed for business in the markets on

Tuesdays,

Tuesdays, Thursdays, and Saturdays. He visited the bulk-store 11th April, and from then till the 16th was occupied at his retail shop; 17th April (Sunday) went early to bathe at Lady Robinson's Beach, thereafter at home; 19th April visited the bulk-store, where he remained about ten minutes, and saw some bags of canary-seed turned over during the morning; 20th was occupied entirely at the retail shop.

History of Illness.—20th April went to work as usual, and continued in usual health throughout the day; went to bed still well; was roused about 11·30 p.m. by headache, pain in the loins, shivering, fever; he vomited before daybreak. 21st, eat no breakfast; was visited by Dr. Abbott, who examined the superficial lymphatic glands, and found they presented no enlargement or tenderness. 22nd, afternoon, pain in right groin, where he felt a small lump. 23rd, 10 a.m., exhibited a visible swelling in right Scarpa's triangle, which was caused by an enlarged femoral gland and a good deal of periadenitic effusion (1st June a second femoral and an inguinal gland had become slightly enlarged). Distinct remains of a flea-bite were seen 5 inches above the right external malleolus, and there were three others on the lower part of the abdomen (patient said he was rarely or never bitten by fleas); no other lesions of drainage area.

Residence.—Detached villa, brick, one storey, six rooms; three aviaries and a fowl-house; no stable in near neighbourhood; no trade use. Connected with sewers; clean, and in good sanitary state; one bedroom disinfected 23rd April.

Employment.—The building was of one storey, and contained one room only; not in communication with any other building.

Rats.—At residence, no traces. In the course of routine inspections the retail shop had been found rat-infested, and the owner had consequently been served with notice to put in a concrete floor on 30th March; at the date of attack this work was still in progress, so that few signs of infestation were then visible. Rat-catchers of the City staff had been at work at the market and in its neighbourhood for many days; on 19th April one of the carcases delivered by them at the laboratories was found to be plague-infected. On removal of the stock from the bulk store in the markets, which consisted of about 80 bags of canary-seed, to another place (it was not further interfered with), the wooden floor was found to be full of rat holes, and on taking it up burrows were traced under the flagstones of the market pavement and under the adjoining street pavement; the earth was excavated to a depth of about 3 feet, and it was found that the burrows extended many yards. This work was carried on between the 19th and the 25th; it resulted in collection of 83 rats, in 24 of which plague was identified (65 were gatnered on the 21st and 22nd, of which 17 were infected). Portion of the stock of canary-seed had been recently landed at Adelaide Wharf, where plague-rats had been found on and after 14th April.

Contacts and further Cases.—At residence, 4; at employment not noted; no further cases occurred.

Case D.

Summary.—W.O'N., m., æt. 17, unmarried, labourer. No former attack; not inoculated; no communication with any previous case. Residence, Factory-street, Parramatta, about 14 miles from his place of employment, which was at Wearne's grist-mills, Dixon-street, within the city of Sydney. Notified by Dr. R. Bowman at midday, 25th April; visited by the Assistant Medical Officer of the Government at Parramatta District Hospital, and reported for removal at 3·10 p.m.; admitted to Coast Hospital, April 26th, 6 p.m., patient's state and length of journey by road having rendered delay necessary; discharged 2nd June; duration of illness, 40 days. Right femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was out of work, went frequently to Sydney by train, and visited many different suburbs. 16th April engaged at Wearne's mill, to begin 18th; remained at home 17th (Sunday), and thereafter moved only between his house and the mill.

History of Illness.—22nd April, 1 p.m., felt pain across loins, and at 3 p.m. pain in right groin; he was giddy and weak, but finished his day; shivered during the evening, went to bed at 9 p.m., and remembered nothing thereafter until he came to himself in Parramatta Hospital, where he was admitted 23rd, 7 p.m. On examination, 25th, exhibited a right femoral bubo about the size of a pigeon's egg, with some periadenitic effusion; no lesions of drainage area, except flea-bites.

Residence.—Detached brick and weatherboard cottage, one storey, four rooms; walls damp; pail-closet, clean; no trade carried on; no stable in close neighbourhood. One bedroom disinfected 26th April.

Employment.—An old brick building, five storeys, very much out of repair; wooden flooring in basement; a good deal of maize, wheat, and oats awaited grinding.

Rats.—At residence, no signs. At employment, patient said he had seen none; on inspection there were signs of past and present infestation, and between 27th April and 5th May 71 rats and 29 mice were collected; plague was identified in 2 rats and 2 mice.

Contacts and further Cases.—There were no further cases.

Case E.

Summary.—W.J.J.H., m., æt. 33, married, carter. No former attack; not inoculated; no communication with any previous case. Residence, 96, Reservoir-street, City, about a quarter of a mile from his employment, which was at Hop Lee and Company, fruit salesmen, 26, Campbell-street, City. Notified by Dr. Corlette, 26th April; visited by the Senior Medical Officer of Health (Dr. W. G. Armstrong, M.B., D.P.H.) at 2 p.m., and reported for removal same time; admitted to Coast Hospital 26th April, 5·30 p.m.; died, 30th April; duration, 84 hours. Right femoral bubo; morphological and cultural tests positive (later, inguinal glands enlarged as well).

Movements prior to Attack.—In his present employment, five years; was occupied in carting fruit, &c., from Sussex-street wharves to Campbell-street every day; delivered a load at Adelaide Wharf, No. 1, otherwise called Grafton Wharf, 22nd April; 23rd April (Saturday), afternoon, paraded with Field Artillery; last at work, 25th April, 6 p.m.; stabled his horse at livery stable, 28, Campbell-street.

History of Illness.—Worked as usual, 25th April; afterwards went to Victoria Barracks; retired to bed in usual health; attack sudden about midnight; felt first a sharp pain in right groin, and found a small lump; then high fever and general weakness; no other pain. 26th April, 2 p.m., exhibited a small right femoral bubo about the size of an almond, not painful and only slightly tender. On limbs and chest was an extensive inflammation of the hair follicles caused by dirt; at many points there were small pustules. No other lesion of the drainage area visible.

Residence.—Two-storey cottage, in a terrace; brick, clean, good repair; connected with sewers; no trade use; no stable near. One bedroom disinfected 27th April. *Employment.*—

Employment.—Brick, concrete floor to basement, very clean and well kept.

Rats.—At residence, no traces; at employment, no traces. At Grafton Wharf, where patient had delivered a load 22nd April, and was occupied nearly all day, plague-rats were taken 14th, 18th, and 20th April.

Contacts and further Cases.—At residence, 4; at employment, not noted. No further cases occurred.

CASE F.

Summary.—C.E.C., m., æt. 33, single, labourer. No former attack; not inoculated; no communication with any previous case. Residence, 68, Druitt-street, City; employment, Town Hall close by. Notified by Dr. Morgan Martin, 12th May, 9·30 a.m.; visited by the Assistant Medical Officer of the Government, 10 a.m.; reported for removal at 11 a.m.; admitted to Coast Hospital, 2·30 p.m.; discharged, 3rd June; duration of illness, 27 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Patient had been a member of the cleansing gang employed by the Local Authority for the City of Sydney for a long time. Was occupied in cleansing Wearne's grist-mill (see Case D), 28th April to 5th May (on the included Sunday he stayed at home); 6th and 7th May he was employed at other premises where no plague-rats had been or were afterwards found.

History of Illness.—8th May (Sunday) felt slight pain in left groin on stooping to put on his boots, and found a small lump; was well, eat breakfast, went to bathe at Coogee, returned; at 11 a.m., found himself too tremulous to shave; soon after became giddy, frontal headache began, eyes became suffused and ran, and he found the lump in the groin more tender and larger. Afterwards he shivered from time to time, and at 3 p.m. noticed the bubo had become still larger. Thereafter he experienced the usual symptoms in rather slight degree, including sleeplessness; but on the night 11th to 12th, he slept well. At examination 12th May, he exhibited a left femoral bubo, which consisted of two glands enlarged and enveloped in a mass of effusion, the whole about the size of a pigeon's egg.

Residence.—A three-storey brick house of eight rooms in a terrace; cleanliness and general sanitary state fair to good; connected with sewers. Premises used as a lodging-house; no stables near by. One bedroom disinfected 12th May.

Employment.—See Wearne's mill, Case D.

Rats.—Residence, one rat-hole in a front room was evidence of past infestation; but there were no present signs. Employment, see Case D, Wearne's mill.

Contacts and further Cases.—At residence, 18; at employment (engaged together with him in cleansing the mill), 10. No further cases occurred.

CASE G.

Summary.—G.C., m., æt. 49, married, labourer. No former attack; inoculated Sydney, 1900; no communication with any previous case. Residence, 31, Murray-street, Pyrmont, within the city, about half-a-mile across Darling Harbour from his place of employment, which was at Federal Bond and Stores, on the easterly shore of Darling Harbour. Notified by a member of the Departmental rat staff, 27th May, 9·30 a.m.; visited by Assistant Medical Officer of the Government, 10·30; reported for removal, 11·45; admitted to Coast Hospital, 5·15 p.m.; discharged, 9th August; duration of illness, 46 days. Left femoral bubo; morphological and cultural tests positive.

Movements before Attack.—Was regularly employed as a store hand at Federal Bond and Stores for long before illness, and was last at work 26th May. Walked to and from work, and ate his lunch on the premises.

History of Illness.—25th May, went to bed in usual health; was roused by severe frontal headache and shivering about 11·30 p.m.; was giddy and weak on rising next morning, but went to work; at 10 a.m., 26th May, noticed a slight cutting pain in the left groin, and at 11 went home; during the evening noticed a severer pain in the groin, and found a lump there; was visited by his lodge doctor at 6 p.m. On examination, 27th May, the bubo consisted of two or three enlarged femoral glands, of which the biggest was the size of a marble. No lesions of drainage area were visible (skin very dirty).

Residence.—A two-storey brick cottage of four rooms in a terrace; connected with sewers; no trade use; cleanliness and ventilation bad; walls, ceilings, and bedding dirty and infested with bugs. No stables in close neighbourhood. One bedroom disinfected 28th May.

Employment.—A brick building of two storeys, and four large sheds of iron and wood, in which a variety of articles were stored, among them a large quantity of oats, wheat, barley, and chaff. He was occupied in moving, stacking, &c., the articles in store.

Rats.—At residence, no signs. From Federal Bond, Stores (diagram No. 15), and adjoining wharf 21 rats were submitted between 25th and 28th May, of which 4 were infected with plague. 24th May, patient said he found a dead rat in one of the stores, which he wrapped in paper and gave to the rat-catcher (rat-catcher confirmed this); this rat yielded smears which aroused suspicion of plague, but the cultures which were made became overgrown; 25th May, he found another, which he also wrapped in paper, and gave to the rat-catcher; the rat-catcher himself took another rat at the bond, and submitted both; plague was identified in one of them, but there was nothing to show which of the two was that picked up by the patient. (Cf. Case L below.)

Contacts and further Cases.—At residence, 4; at employment, not noted. No further cases occurred.

CASE H.

Summary.—W.W., m., æt. 20, unmarried, labourer. No former attack; not previously inoculated; had had no communication with any previous case. Residence, Raglan-street, Waterloo, about 6 miles north of his place of employment, which was at the Federal Paper Mills, Botany. Admitted to the general wards at the Coast Hospital, 31st May; died, 6th June; duration of illness, 6 days. Slight swelling of a right femoral gland (first appeared sixth day); morphological, cultural, and inoculation tests positive.

Movements before Attack.—Had been employed at the paper-mill for a considerable time, and the books showed that he had recently been absent only for an hour on 17th, and for half a day on 18th May, when (his relatives said) he had a bad cold. He went to and from work by tram, and had spent his own time either at home or in his neighbourhood, but on Saturday nights he usually went into the city for amusement.

History

History of Illness.—His relatives said he was an epileptic, but was well before, and on the day of, attack. He was brought to the hospital 31st May, on a lorry, by his fellow workmen, who said he had worked as usual during the morning, and had eaten a good lunch at 12; he resumed work at 1 p.m.; at 2·30 he shivered, became giddy, and complained of general pains about the body; very soon afterwards he staggered out of the shed, where he was occupied in sorting rags, and fell to the ground; he was unconscious, or, as his friends said, "his face was flushed, and he would not answer questions"; he was further said to have had a convulsion on the way to the hospital, where he arrived about 3 p.m. He was admitted to a general ward under care of a Medical Officer (Dr. W. W. Stevens, M.B., B.Ch.) of considerable clinical experience with plague. This disease was borne in mind in making the diagnosis, and the superficial lymphatic ganglia were examined daily. His symptoms consisted almost entirely in high fever, delirium with great restlessness, a slight cough from the beginning, epistaxis, some diarrhœa, and meteorism; commencement of the sixth day (5th June, evening) tenderness was found in the right groin, where, twelve hours later, one of the femoral glands had become a little bigger than a pea; at the same time the physical signs of pneumonia became apparent over the right base, and were fully developed the next morning. He died at 11·30 a.m., 6th June. No examination was made *post-mortem*.

Residence.—A weatherboard cottage of one storey, four rooms; a poor place, tolerably clean, but in bad sanitary condition; no trade use; no stables very near. Not disinfected.

Employment.—A paper-mill, about 6 miles south of residence, standing on scrub land, near swamps. The premises were very extensive, not old, and very well constructed; concrete floors throughout—to sorting-sheds as well as to brick buildings. There was a large stock of material awaiting manufacture, which amounted to about 7,500 bales; it consisted of some rags, but chiefly of waste paper, rope, jute bagging, &c., &c. There were about 2,000 cubic yards of similar matter which had been dumped in the open, and had there rotted. The place was cleansed by a staff of men employed by the company, but under direction of Departmental sanitary inspectors; the stock was moved, enclosed under tarpaulins, fumigated with sulphur for expulsion of rats (if any), and restacked. The rotting material was spread out in a layer 18 inches thick, and covered with engine-ashes, after having been sprayed with miscible carbolic.

Rats.—At residence, no signs of infestation. At employment, between 10th and 23rd June, rat-catchers submitted 34 rats, 125 mice, and 5 native cats (*Dasyurus Viverinus*, Shaw); the cleansing staff found only 1 rat with 4 young, 6 mice, and 2 native cats; no holes, burrows, &c. Plague was identified in 1 rat taken 10th June, and 1 mouse taken 16th June; the whole number were examined in the laboratory in the usual way, but all had been trapped, and, therefore, were either all in good health, or if at all infected but slightly so. The premises themselves offered no signs of infestation, and it was conjectured that the rodents taken were introduced with the bales of material which were delivered daily. The supplies referred to were collected at two places adjoining each other in Harbour-street, Darling Harbour. One belonged to the company, the other to a rag-dealer; they were situated next to Wearne's mill (see Case D), and both had doors which opened on a yard on which Wearne's mill also opened. At the latter place plague-rats were taken between 27th April and 3rd May, but not later.

Contacts and further Cases.—At residence, 4; at employment, 63 men and 44 women were employed—total, 107; 37 were occupied in the sorting-shed, where W.W. worked. No further cases occurred.

Case I.

Summary.—R.S., f., æt. 15, unmarried, milliner's apprentice. No former attack; inoculated Sydney, 1900; no communication with any previous case. Residence, Town's Wharf, Miller's Point, about a mile from her place of employment, which was at 502, George-street, City. Notified by Dr. E. H. Binney, 21st June, midday; visited by the Assistant Medical Officer of the Government at 12·30; reported for removal 2 p.m.; admitted to the Coast Hospital 6·30 p.m.; died 22nd June, 6·30 p.m.; duration of illness, 76 hours. Left sub-pectoral and left cervical buboes; morphological test applied to liquid from a swollen gland, and to blood withdrawn from the general circulation, 21st June, midday, both positive.

Movements before Attack.—Between residence and employment only.

History of Illness.—Was in good health. 19th June went to work as usual; at 3 p.m. shivering and frontal headache; 20th June, first felt pain about the left axilla, which gradually increased; during the evening her pulse and temperature were normal (Dr. Binney); during the ensuing night first felt pain in the left side of the neck. 21st June, midday, T. 102·4, P. 128; exhibited a small, very tender, bubo under the border of the left pectoralis major; just above the clavicle a slightly enlarged and tender posterior cervical gland was detected. Death by cardiac failure.

Residence.—Town's Wharf, where her father was watchman. A brick two-storey cottage of six rooms, which was attached to, and formed part of, a bonded store, from which it was separated by a wood-and-iron partition; lighting and ventilation bad; the patient's bedroom had no outside window. Three rooms disinfected 22nd June.

Employment.—A brick house of three floors, in a satisfactory state; patient worked in a room on the second floor, which was in good sanitary condition.

Rats.—Residence. Dead rats were found beneath the kitchen floor and at parts of the adjoining bonded store; the carcases were putrid. During the 115 days—1st February to 25th May—89 successful visits had been paid to this wharf and the stores in the enclosure attached to it; they yielded 136 rats and 73 mice, all of which had been examined in the laboratories, and had been found healthy. On 26th and 27th May, 7 rats and 3 mice were submitted, of which 3 rats and 1 mouse were infected. Between 30th May and 13th June, 11 successful visits yielded 17 rats and 18 mice, all of which were healthy. On 14th June, 2 rats and 2 mice were brought in, of which 1 mouse was infected. During 136 subsequent days 61 successful visits were paid to these premises; they yielded 44 rats and 61 mice, all of which were examined in the laboratories, and were found to be healthy. At employment, no trace of infestation.

Contacts and further Cases.—No further cases occurred.

Case K.

Summary.—L.B., m., æt. 40, married, shipping clerk. Residence, 187, Edgecliffe-road, about 3 miles south-westerly from his place of employment, which was at 170, Clarence-street, City. No former attack; not inoculated; no communication with any previous case. Notified by Dr. O'Gorman Hughes

3rd August, 1·30 p.m.; visited by the Assistant Medical Officer of the Government at 3·40; reported for removal at 5·10; admitted to the Coast Hospital 9 p.m.; died 4th August, 9·30 a.m.; duration of illness, 96 hours. Bubo, left sub-pectoral; morphological and cultural tests positive.

Movements before Attack.—Had been at his business regularly for a considerable time; he was chiefly occupied at his office in Clarence-street, but had to visit daily the head offices of various shipping companies which were not near wharves; and he had visited only one wharf during the preceding three weeks, namely, the office attached to Howard Smith and Company's wharf, where he called 30th July; otherwise he had moved only between home and place of employment.

History of Illness.—30th July (Saturday) in good health, went to work as usual; in the afternoon had headache, but eat a good tea, went to an election meeting in the evening, and slept well at night. 31st, shivered at 8 a.m., felt generally unwell during the morning, headache, giddiness, and vomiting; uneasiness in left axilla about 9 p.m. 1st August, still felt feverish, vomited several times, restless, no appetite, the axillary pain was much increased and a lump was felt. 2nd August, same symptoms; did not feel very ill. 3rd August, first sought medical advice. About midday was found in bed, feeling weak, not apparently very ill; had had some diarrhœa, complained of axillary pain; the bubo consisted in a large doughy mass, in which a gland could be felt; T. 102·8, P. 99, R. normal. Lesions of drainage area, none. He subsequently said he had cut his left thumb slightly on radial side of nail with a penknife 24th July; this had bled on 25th and 26th while he was at his office, and he had dried up the blood with blotting-paper. Died 4th August, 9·30 a.m., cardiac failure, mind clear.

Residence.—Brick terrace house of five rooms, with basement; connected with sewers, very good sanitary condition, and very clean; no trade use; no stable near. Bedroom occupied by patient disinfected 5th August.

Employment.—A warehouse used by a firm of carrying agents, brick, four floors, excellent repair, general sanitary condition good, cleanliness fair; patient's office on ground-floor; no stables or outhouses; basement concreted; all rooms ceiled wood. A considerable store of general merchandise, including a few bales of hops and about 2 tons of bird-seed. Searched and disinfected 5th August.

Rats.—At residence, no traces. At employment, search revealed abundant signs of present infestation, in the shape of fresh dung, and the carcases of three or four recently dead rats; rat-dung was found in a drawer of the desk which deceased used habitually; plague was identified in the carcases of 2 rats and 1 mouse collected in the store 4th to 8th August.

Contacts and further Cases.—At residence, 1; at employment, 11 men, 1 woman. No further cases occurred.

Case L.

Summary.—P.D., m., æt. 26, single, a coachman in private employment. No previous attack; not inoculated; no communication with any former case. Residence and employment, Curzon Hall, Marsfield, a suburb of North Sydney; but on 9th September, after falling ill, went to his father's house, 228, Trafalgar-street, Annandale, a suburb of Sydney. Notified by the Coroner 11th September; duration of illness, 51 hours. Notes of the *post-mortem* examination were furnished by Dr. Stratford Sheldon, by whom they were made about fourteen hours after death:—"*Rigor mortis* and *post-mortem* lividity well marked; no swellings or marks of identification. The inguinal glands were dissected out; they were rather high-coloured on both sides, but not enlarged; cervical and axillary glands were not enlarged. The blood was dark and tarry. There were signs of ecchymosis in the loose tissue around the right eye, and sub-conjunctival ecchymosis of the left eye. Brain, intense venous congestion. Heart: about two drachms of clear fluid in the pericardium; left side engorged with clots; right side empty; petechial subserous hæmorrhages. Pleuræ contained about an ounce of clear fluid in each; the lungs were quite normal in appearance, and there was no congestion. There were very marked subperitoneal ecchymoses on the posterior wall of the abdomen, and the areolar tissue round the kidneys was intensely congested with dark venous blood; there were subserous hæmorrhages on the small intestine at various points; the kidneys were swollen, soft, very full of dark blood, and showed subserous petechial hæmorrhages. The liver was about normal, no marked congestion. Spleen large, soft, very congested. The bladder was empty. Both iliac veins were congested; the left appeared to be inflamed, and was full of breaking-down clot." To a portion of the spleen which had been preserved in carbolic solution the Microbiologist applied morphological, cultural, and inoculation tests with positive results.

Movements before Attack.—Had been in his present employment two years. Went to Annandale 3rd September, returned 4th, evening.

History of Illness.—It was ascertained, after examination of several members of the household, that he was in his usual health during the forepart of 7th September; but that while driving a carriage to meet the train late in the afternoon he complained of shivering to a fellow servant who accompanied him. Having returned, he put his horses up, changed his clothes, and went to a party at a neighbour's, but was too unwell to stay more than half an hour. 8th September, remained in bed all day; he was visited and attended from time to time by M.L. (Case M, see below), the housekeeper, and by Mrs. G., an occasional domestic assistant; he had headache, fever, and vomiting. On 9th September, he decided to go to his parents, at Annandale; he went to Sydney by train, and arrived at Annandale about midday. At 5 p.m. he was visited by Dr. H. B. Ludlow, who found him suffering from diarrhœa and vomiting, tongue and lips dry, T. 103; he had a swelling along the inner side of the left thigh, which was not markedly tender, and tenderness in the right hypogastric region; his general state was described as having been "typhoidal." About 8·30, Dr. Ludlow returned, and found the patient had just died; he noted that the body was already livid, and growing darker. He declined to certify to the cause of death, and informed the police.

Residence (of parents at Annandale).—A detached weatherboard cottage, one storey, five rooms, one fowl-house; general sanitary state good; connected with sewers; no trade use; no near stable. Bedroom where patient had lain disinfected 12th September.

Employment (Curzon Hall, Marsfield).—A private residence standing on a considerable area of land; built of stone, two stories, twenty-six rooms, large basements; general sanitary state satisfactory. The patient inhabited the stables. These were of stone, two stories. On the ground-floor was stabling for six horses; at one end a kind of office, at the other a coach-house, harness-room, and a lumber store. On the upper floor was a large loft over the stalls, which contained about 220 bags of chaff, oat husks, &c.; over the coach-

coach-house, &c., were some empty rooms; and over the office was the patient's bedroom. There were other structures in the grounds which, after examination, turned out to have no special importance in the present connection; and about 400 yards from the house was a large building, partly of stone, which was sometimes used as a church. It contained one room, used as a bedroom by some out-door servants, as well as three basement rooms, of which one was used as a store for chaff, and contained about twenty bags. Between 12th and 17th September the premises were cleansed by a staff of six men, furnished by the proprietor, assisted by two members of a former cleansing staff, under direction of Departmental Sanitary Inspectors Getting and Lloyd. Occasion for cleansing operations was found to be confined to the stables and the distant building last-mentioned; they were disinfected and lime-washed. The bags of feed were examined, broken bags being opened out. Between 80 and 90 such bags were burnt, together with their contents; the sound bags were merely ransacked, and were not otherwise interfered with.

Rats.—Inquiries made of different persons showed that before he fell ill deceased had killed a sick rat which he saw crawling across the floor of his bedroom when he rose one morning, and had at the same time found two dead rats either in his bedroom or in the loft on which it opened. He had told this to his sister at Annandale, to a friend at Marsfield, and to one of the outdoor servants at Curzon Hall, all of whom were separately questioned. One of these witnesses thought he had said he found the rats on the 6th; one could only remember that he had said the finding happened about the 6th—that day having been the day before his attack, and the time referred to about 30 hours before attack. The third witness thought he was told it happened "two days before he fell ill," or on the 5th. It appeared that no other dead rats had been observed with exception of 2 reported by the stable boy; the date on which he saw them could not be fixed, and they may have been part of the three above-mentioned. The stable was found to be badly infested; rat droppings were thickly strewn over the floor of the loft and the chaff bags, which latter were also rat-eaten; much loose chaff, intermingled with rat-droppings, lay about the floor; three putrid carcases were found in a coil of rope about 3 yards from the bedroom door; the other rooms on that floor, and the rooms (except the stalls) on the ground floor were similarly bestrewn. But there were no burrows or holes in the woodwork, and nests were found only among the chaff and in the harness-room (the buildings were not only solidly constructed and in good order, but stood on a soil which was either shale or, in places, very hard clay). A similar state of things was found at the distant building above-mentioned, in some parts of it; and the chaff stored there was part of the same consignment as was stored at the stables. Many stacks of timber, as well as green-houses, bush-houses, &c., and other places existed in the extensive grounds, which seemed likely to afford harbourage for rats; they were carefully examined and found not to be infested. The house itself offered no signs of infestation; traps, decoy-baits, &c., were set, and 1 rat and 1 mouse, which were healthy, were caught; but it was thought they had wandered in. The statement of the experienced officers who supervised the operations throughout was that the presence of rats was connected with the forage, and as a matter of fact it was confined to the stables and to the distant building, in which two places alone the forage had been put. Between 12th and 16th September remains of 56 rats, collected on these premises, were referred to the laboratories. Eleven were skeletons only; 24 were decomposed, but had died rather recently; 14 had been trapped; 2 had been killed; 5 had been found dead. Plague was identified in 2 trapped rats from the stables, and in 1 rat killed at the distant building. Additional were 4 mice trapped at the stables, in one of which plague was identified. The horse feed found on the premises had been supplied by a dealer trading at 9, Wharf-street (Diagram No. 24), from the beginning of the year; he made the general statement in reply to his customer's inquiry by letter that the latter's supplies had been usually forwarded direct from the railway yards by train (that is, without having been at Wharf-street), but that 167 bags of chaff, delivered 11th May, had lain for 3 or 4 months previously at Federal Stores (Diagram No. 15), while the corn, or some of it, had been forwarded direct from the North Coast Company's wharf (north of No. 10 Diagram). Deliveries by this dealer at Curzon Hall (to limit inquiry to the important period) had been as follows:—11th May, 167 bags of chaff; 12th May, 8 bags maize; 27th May, 70 bags chaff; 28th June, 14 bags maize; 27th July, 10 bags maize, 7 bags bran; 1st August, 80 bags chaff. Then as regards rats, it is only necessary to say here that plague-rats were first detected at Federal Stores on 25th May, and were again found there on 14th June; they were also found in great number at the dealer's own store, 9, Wharf-street, and first on 24th June. But under the circumstances, while any produce store in the neighbourhood may have had importance in relation to infection of Curzon Hall—and many yielded plague-rats at one or another time—at all events two produce stores next to No. 9, namely, Nos. 7 and 5, should be noticed, although they were not, as far as could be learned, in communication with No. 9 for rats, and at all events were ostensibly separate premises. Then, plague-rats were found on No. 5 on 16th June, and at No. 7 on 7th to 11th June, and again between 1st and 9th July. These are the available facts; nothing further could be discovered, but it can be added that feed was supplied only by these dealers. Comparison of the dates of attack, of delivery of supplies, and of discovery of plague-rats at the stores does not make it possible to fix on any particular delivery as having been that which conveyed the infection. One point, however, seems ascertained: it is that the infection must have reached Curzon Hall at least 36 days before it was revealed by its effects on the stable rats, because the latest delivery was made 1st August. Our records in general show, however, that plague may persist among a horde for long without making much progress or infecting a large proportion of it, and it may well be that the infection was conveyed in a still earlier consignment.

Contacts and further Cases.—At Annandale, 4. At Curzon Hall 1 further case occurred. (See Case M.)

Case M.

Summary.—M.L., f., æt. 31, single, housekeeper. Residence and employment, Curzon Hall, Marsfield. No former attack; not inoculated; had had communication with P.D., Case L, whom she attended while he lay ill in his room at the stables. Notified 12th September, 12·30 p.m., to the Assistant Medical Officer of the Government, who was then examining the premises in connection with Case L. Died 3·50 p.m.; duration of illness, 53 hours. Morphological and cultural tests, positive.

Movements before Attack.—Had been employed for a considerable time, and had not been away from the premises for fourteen days or more.

History of Illness.—10th September: rose in her usual health; at 11 a.m., headache, shivering, and "bilious feeling"; slept well during the ensuing night. 11th September: morning, felt generally worse; vomited frequently thenceforward; in the evening diarrhœa set in, and continued thenceforward. 12th September:

September: early in the day noticed a small and tender swelling in the right groin. Medical advice was not sought. On examination at 12·30 p.m., T. 103·2, P. 152, R. 34; tongue lightly coated, moist, lips dry; evident appearance of illness; very nervous, and frightened by the death of P.D.; a right femoral gland was slightly enlarged, not very tender, and there was also slight enlargement of right inguinal glands; morphological test applied to liquid abstracted from the former, and to blood taken from the right middle finger, positive; the former contained innumerable, the latter abundant, bacilli. About five small punctate marks, like flea-bites, over surface of bubo; no other lesions. A fellow servant with her at 3·50 p.m. said she had been talking rationally, when she suddenly gasped and died.

Residence and Rats.—See Case L. above. M.L. slept in the house. 8th September she visited P.D., who then lay ill in his bedroom over the stables, to see to his wants, and was reported to have sat with him during part of the night 8th to 9th. Mrs. G. (the casual assistant mentioned above under Case L) also sat with P.D. from time to time. Contacts, 8. No further cases occurred. The bedroom occupied by this patient was alone disinfected.

21. The buboes were femoral in 7 cases—A, B, C, D, E(d)*, F, and G; in cases C and E(d), some or all of the associated inguinal glands became tangibly swollen later. They were subpectoral in two cases, K(d) and I(d); the former remained solitary, the latter was followed by painful, hard swelling (a secondary bubo) of a cervical gland on the same side.

22. These 9 primary buboes made appearance as follows:—There was pain in the gland before other symptoms in cases B, E(d), and F, accompanied in F by slight swelling; there was pain at the onset, with other symptoms, in Case A; in Cases D, G, K(d), I(d), and C, pain (accompanied in C by observed swelling) was first felt in 2, 10, 13, 18, and 40 hours after attack, respectively.

23. It should be specially noted that in at least 3 cases out of the 12 the disease-process clearly first manifested itself in that gland in which a primary bubo subsequently developed. This was also observed in 13 cases of the outbreak of 1902 (Report, 1902, par. 24.)

24. In the other 3 cases, H(d), L(d), and M(d), defined buboes were not exhibited. In the case of H(d) there was no tangible swelling of any superficial gland (careful daily examination was made) until the 6th and last day of illness; in that of L(d) there was no tangible swelling of any gland during life, but all were found engorged *post mortem*; in that of M(d) there was slight tangible but not very tender swelling of the right femoral and inguinal glands only, which was detected about the 48th hour of illness, when the patient was first examined—*i.e.*, about 4 hours before death.

25. The following note on the bacteriological diagnosis of the cases, and on presence of the bacillus in the blood-stream during life, has been furnished by the Microbiologist.

The results of examinations of material taken from the buboes or enlarged glands, and of blood taken from the ear (including with the latter material from the spleen of the Case L. (seen only after death) are given in the following table:—

TABLE II.—1904.

Case.	Material from enlarged glands.			Blood.			Issue.
	Smears.	Cultures.	Inoculations.	Smears.	Cultures.	Inoculations.	
A	+	+	+	0	0	0	Recovered.
B	+	+	+	0	0	•	,,
C	+	+	+	0	0	•	,,
D	+	+	•	0	+	•	,,
E	+	+	•	0	+	•	Died.
F	+	+	•	0	0	•	Recovered.
G	+	+	•	0	0	•	,,
H	•	+	+	•	•	•	Died.
I	+	+	•	+	+	•	,,
K	+	+	•	+	+	•	,,
L	•	•	•	+	+	+	,,
M	+	+	•	+	+	•	,,

The bacteriological examination resulted in the detection of plague bacilli in all of the cases.

Material from buboes or swollen glands was examined in eleven of the cases. Smear preparations of it showed plague bacilli in ten, all confirmed by culture, and the first three of them by the positive results of inoculations performed on guinea pigs. In the other case (H) cultures only were made. They gave a growth of bacillus pestis which produced fatal plague in the guinea pig inoculated with it.

The results of the examinations of the blood taken from the ears or fingers of eleven of the patients during life, and of material taken from the spleen of one case after death, show that six of the twelve cases (D, E, I, K, L, M) were septicæmic. Probably Case H was also of this type (*vide* clinical account), making in all seven septicæmic cases. The bacilli were not found in the blood of the other five patients.

Of

* d=died.

Of the seven septicæmic cases six died and one (D) recovered. The specimen of blood from Case D, which yielded positive results on culture only (the bacilli not being detected in the smears), was taken on April 25th, 1904. A second specimen, taken two days later (April 27th), gave negative results with both smears and cultures. In the interval between the two examinations the patient had received 340 ccm. of serum (Yersin). Of the fatal cases, one (H) was not definitely proved to be septicæmic (*vide supra*), and another (L) died prior to coming under observation. The other four were shown to be septicæmic during life. Two of them (I and M) died on the same day that the specimen yielding plague bacilli was taken from them; one (K) died on the next day, and one (E) on the fourth day after the septicæmic blood was taken. The five non-septicæmic cases all recovered. F. T.

26. In the nine cases which exhibited primary buboes search for points of entry of the infection resulted as shown in the table below :—

TABLE III.—1904.

Case.	Situation of Bubo.	Lesion of Drainage Area.
A	Femoral	Traces of flea-bites; no local reaction.
B	„	Recent finger-nail scratches.
C	„	Traces of flea-bites; no local reaction.
D	„	„ „
E(d)	„	Inflammation and pustulation of hair follicles (dirt).
F	„	None.
G	„	„
I(d)	Subpectoral	„
K(d)	„	„ (but see note).

NOTE.—On reference to the account of Case K(d) above, it will be seen that the patient had cut his thumb with a pen-knife 7 days before attack; that the wound had bled on the 6th and 5th days before it; that he had dried the blood with blotting-paper at his office; that rat's dung was found in the drawer of the office-table he used; and that plague-rats were identified on the premises during search after notification of his case. If he received the infection through the wound (but I know of no experimental evidence touching possibility of infecting animals with plague by inoculation of the dung of plague-infected rats), apparently his bubo should have occurred in the axillary glands; in fact it appeared in a subpectoral gland, while the axillary glands were not tangibly enlarged. This case should be compared with that related to the Plague Commission in India by Captain H. W. Elphick, I.M.S. (Q. 9568), in which a hospital assistant who had wounded the back of his hand with a rib of a plague-corpse fell ill with plague within 48 hours afterwards, and exhibited no axillary, but a subpectoral bubo. Captain Elphick accepted the case as showing "that the bubo is not necessarily situated in the group of glands directly related to the seat of inoculation." It is worth noting that when his patient was first examined (namely about 48 hours after receipt of the injury) the scratches had quite healed, and showed no signs of local reaction. Absence of local reaction and of lymphangitis were noted in the case of K(d), and in the following also which occurred during the current year at Newcastle. Dr. L. wounded his left hand twice in making a *post mortem* examination of the body of a man who had died of plague; pure carbolic acid was at once applied to these injuries. Almost exactly 24 hours later he began to feel ill, and at the same time felt discomfort in his right axilla, where a bubo subsequently developed. This drew attention to his right hand on which a very small breach of the epithelium was discovered at the base of one of the nails. The diagnosis of plague was bacteriologically confirmed in the usual way. The wounds of the left hand seemed to give no trouble.

27. In the case of E(d) alone, then, were there visible lesions of the drainage area (as well as of other parts of the body-surface) which might have furnished points of entrance for deposited infection casually encountered; for the finger-nail scratches in Case B had an appearance of recency when they were first examined at the 72nd hour of illness—much longer, therefore, after the hour of infection—so that it is almost certain they were made after the infection had been received, and were not the point of entrance. So also the traces of flea-bites in Cases A, C, and D, were first observed at the 29th, 58th, and 72nd hour of illness (much longer after reception of the infection), and for that reason could not be conclusively regarded as points of entry. Lastly, in the 4 cases F, G, K(d), and I(d), no lesion could be found. In point of fact, any lesion of the skin which was minute, though sufficient to give entrance to the virus, had had ample time to heal before these patients fell under observation; and, in general, it is not to be expected that such a lesion should be identifiable, unless the virus had caused inflammatory changes in its neighbourhood, or unless its infliction had been attended by sharp pain, or by some other circumstance which attracted attention at the time.

28. As regards inoculation of the virus into the (damaged or broken) skin of drainage-areas by casual contact with inanimate bodies infected by wandering plague-rats, it is to be observed that while the dwelling was the place of infection in cases I(d), L(d), and M(d), who, therefore, were certainly exposed to that risk, the infection was received at places of employment in the remaining 9 cases. These 9 patients were

were then shod, and, the season having been winter, were otherwise fully clothed. Case K(d), having been excepted in view of remarks made in a foot-note to Table III, it is difficult to see how the skin of the lower extremity could have been brought into casual contact with deposited infection in the cases in which femoral buboes were exhibited (*Cf.* Report, 1902, pars. 262–70.)

29. A suggestion has been made that the infection may, perhaps, be commonly received by way of the stomach, through the eating of food that has been contaminated by the excreta or by the secretions of plague-rats. It is perhaps worth while, therefore, to refer specially to the 9 persons who were infected at their places of employment, and to point out that workmen carry their dinner with them in parcels, in which it remains until eaten. It cannot be reasonably assumed that the food of these 9 patients had ever been exposed to infection, although it may have been eaten in an infected place.

30. The foregoing details (pars. 20–9) comprise not merely what was learned of each case, but all that was learned. They are complete in essential respects, and they provide a conspectus of the epidemiology of plague, although as the number of cases was but 12 no safe induction could be framed with them. They do not stand alone, however. The conclusions to which they point can be tested by reference to the 303 cases of the outbreak of 1900, to the 139 cases of the outbreak of 1902, and to the two cases of 1903; and when this has been done, it is seen that the phenomena recorded in 1904 agreed precisely with those recorded in former years. That this was so as regards the more important points is shown in the following paragraphs.

31. In the first place, the question whether these 12 patients owed their infection to cases which had preceded theirs must be examined, and with it the correlated question whether any of them communicated infection to persons with whom they were in contact during their illness. Now, the infection in Case A was not received from an earlier case—(*a*) because attack in the last preceding case dated 9 months earlier, (*b*) because absence of communication between A. and any other sick person during more than 10 days prior to his sudden attack was positively established; and (*c*) he was positively known to have worked down to the time of his attack on premises where rodents were dying in unusual number, some of which were ascertained to be infected with plague after his case had been notified. The infection in Case A, then, was not derived from any previous case in man. Nor in the 10 cases, B to L, which next followed upon it, was the infection derived either from A or from any of them. Inter-communication was positively ascertained to have been all but impossible, and certainly did not take place. The 12th patient, M(d), was exposed to L(d) during the first 36 hours of his illness; a possibility of communication of the infection from L to M consequently existed, which will be examined immediately below. It is certain, therefore, that the cause of illness in the 11 cases A to L, did not consist in infection derived from man. The inference thus suggested, namely, that direct communication of the infection from the sick was no factor in production of this epidemic prevalence of bubonic and of septicæmic plague, is shown to be sound as soon as it is tested by comparison with the experience of 1900 and of 1902. In the former year (Report, 1900, p. 32), 276 households furnished 289 cases; 266 households yielded but a single case apiece. In the latter year (Report, 1902, par. 195), 124 households furnished 139 cases; 115 households yielded but a single case apiece. These broad statements, based as they are on the observed facts of 2 outbreaks, each of which was sufficiently extensive to avoid error, and which were widely separated from each other in point of time, suffice by themselves to establish the proposition mentioned above, namely, that these outbreaks did not owe their epidemic character to direct communication of the infection from the sick. And when, as in the year under review, the circumstances of each case are examined minutely, that broad inference is found to stand the test of individual application perfectly.

32. After having shown that epidemics of bubonic and of septicæmic plague are not due to direct communication of infection from the sick, an answer to the subsidiary question, how often such communication does occur, may be sought. The three couplets constituted by cases B and E(d), D and F, L(d) and M(d), were respectively connected with two places of employment and with one residence. A *primâ facie* case for direct communication appears therefore, but it breaks down as

soon

soon as the circumstances are examined. Thus:—B was a labourer regularly employed at a collection of bonded stores to which a wharf was attached, at both of which plague-rats were found; while E, a carman in other employment, was not attacked until 15 days after B, nor until 12 days after B had been isolated. It is not possible that E should have received infection from B. But he had been exposed to the same circumstances as B; for he had worked at the wharf during the whole of the third day before his attack, and the last observed plague-rat at that wharf had been gathered by the intelligence staff the day after he had worked there. So also, although the cases of D and F were connected with the same mill premises, the two men had never met. D was employed at the mill, while F was merely a member of the cleansing gang which entered it 6 days after D had been seized and had gone to his distant home, 5 days after he had been isolated. Communication of the infection from D to F was impossible; and again, there was here merely exposure to the same circumstances, for F was engaged with others in collecting the dead and plague rats which were found at D's place of employment. Between M(d) and L(d) there had been close communication during some part of the first 36 hours of L.'s illness. L, who was a coachman, inhabited stables attached to a large mansion; M, was the housekeeper, and lived in the house, whence she went across to the stables after L had fallen ill, to see to his wants, and she sat up with him at night during the second 24 hours of his illness. The house was not infested by rats, and it was inhabited by other people none of whom suffered. At the stables, L was known to have picked up two dead rats, and to have killed a sick rat in his bedroom above them shortly before attack; and after notification of his case, while putrid carcases were found among dunnage in the loft on which his bedroom opened, and close to its door, plague was identified in 2 rats trapped at the stables at the same time. M was exposed, therefore, not merely to L, but also to the very circumstances in which he had received his infection from some source which quite certainly was not a precedent case in man; and therefore, although the possibility of direct communication cannot be excluded, I am unable to regard it as the most probable explanation of M's case. Thus but a shadow of doubt whether in one couplet out of three the infection may not have been directly communicated from the primary case, falls on the series of 12 cases now under review. I take the opportunity of saying distinctly, however, that I am far from denying the occasional occurrence of direct communication which, indeed, not merely must be possible but has been actually observed by others in specific instances; and of pointing out that my chief concern at this time is not with the occasional causes of individual cases, but with the general, constant, causes of epidemic prevalences of bubonic and of septicæmic plague.

33. How does this part of the teaching drawn from the short series of 1904 stand comparison with the wider experience of 1900 and 1902? In the former year, 10 households out of 276, and in the latter, 9 out of 124 yielded multiple cases; and while in both years some of the secondaries might possibly have received the infection from their primaries, others of them in both years could not have done so. The evidence that this was so cannot be summarised, except at cost of depriving it of all its cogency; reference must be made, therefore, to the original records (Reports, 1900, pp. 34–6; 1902, pars. 196–207) where the circumstances of the two series referred to were described. Nevertheless, attention may be specially directed here to that important group of 7 cases (Report, 1902, pars. 199–202) which actually furnished examples of both the contingencies under discussion, in that while some of its component persons could have received the infection direct, 2 of them could not have done so, for the sufficient reason that they had left the premises before the first of the remaining 5 had fallen ill. On the 2nd and 3rd days after having left they were themselves attacked, on premises to which no suspicion of infection then or afterwards attached. It appears, then, that experience on this point also has been uniform and consistent.

34. But were the other members of the households to which these 12 patients belonged exposed to them sufficiently long after the beginning of their illness for direct communication to have taken place? The time during which such exposure continued was as follows in each case:—E(d), 17 hours; A, 30; G, 36; I(d), 51; L(d), 51 (at home till death); M(d), 52 (at home till death); K(d), 60; C, 63; B, 72; F, 96; D, 99 (part in a general ward); and H(d), 144 hours (in a general ward till death).

If

If with this statement, Table XII, Report, 1900, and Table XX, Report, 1902, be compared, it will be found that all are practically identical. For the most part, the infection had ample time to spread from the 396 cases thus analysed.

35. Thus, secondary cases have occasionally been observed from the beginning. In some of them direct communication was possible; in others, the clinical and other physical conditions of common kinds rendered it either extremely unlikely or even altogether impossible that direct communication should have operated. An unreserved answer to the question—how often the infection was directly communicated from the sick?—therefore, cannot be made; but at all events it is certain that this occurred very seldom at most, and that direct communication was not a factor in causation of any of these epidemics.

36. The infection did not spread directly from the sick;—might it have become diffused by indirect means, that is to say by fomites? That there had not been dissemination of articles from any of the plague-houses of 1904 before they had fallen under the disinfecter's hands is certain; and there is no reason at all for suspecting that such dissemination had taken place during any of the earlier outbreaks as could have explained the epidemic prevalence of the disease, if it be assumed for a moment that the infection can be commonly diffused by that means. Further, if it be granted, for the sake of argument, that there had been dissemination of articles from plague-houses, how could it happen that an infection which did not spread within houses by (direct or) indirect means should become capable of being spread by those same means, provided only the articles were carried outside houses? In short, nothing on this subject of importance can be added to the remarks I originally made (Report, 1900, p. 30), except that no ground for suspecting that the infection may have been diffused by inanimate mediate channels has since been seen.

Were the infection known to be communicated by fleas, then it seems possible that removal of articles outside houses might incidentally cause them to be infective, although (apparently) not so within houses. For during transport the fleas would be starved, and would seize the earliest opportunity of taking blood (*Cf.* Report, 1902, par. 284, Tidswell; Gauthier et Raybaud, Revue d'Hygiéne, XXV, p. 426, May, 1903).

37. The importance of the foregoing observations to all who are practically interested in prevention of plague cannot be exaggerated. They show that the infection was not diffused from the sick, either directly or by intermediary of inanimate bodies; yet they show at the same time that it was diffused. *Thence it necessarily follows that its diffusion was incidental to conditions which obtained independently of man.* For a clue to them, the circumstances in which the infection was received by man must be scrutinised.

38. It has been positively shown that the sole bond between Cases B and E(d) was resort to the same premises; so, also, with Cases D and F. The two premises referred to stood on the same small area within the city. It has also been positively shown that while A, C, G and K (d) were the only cases which occurred at their several dwellings, and in the separate uninfected districts in which their dwellings stood, all of them were employed within the above-mentioned area; lastly, that I(d) both dwelt and was employed on that area. It has been further positively ascertained that these latter 5 had had no communication with each other, nor any with the four former cases (B, E, D, F). It is equally certain, therefore, that the infection was not carried to E(d) or to F, and that they travelled to the infection; the same can be confidently asserted of the cases A, C, G, I(d) and K (d) between whom, also, the sole bond, besides that of their attack with an identical disease, was their resort to the same small area. Thus it appears that the infection was associated with a certain locality, and even with particular premises upon it; those alone suffered who resorted there. If this conclusion be sound, it should also follow from the distribution of cases in each of the preceding outbreaks of 1900–1902–1903. It does so. Data recorded in 1900 (Table XIII, pp. 34–35) showed that at each of 17 work-places more than one workman was attacked; the groups of cases thus formed numbered from 2 to 4, and the total number of persons comprised in them was 43. These 43 persons dwelt away from their work-places in 43 houses (which yielded but a single case apiece), and were ascertained to have had no communication with each other except at their work-places; they were also ascertained to have had no communication with any precedent case of plague. The neighbourhoods in which they lived resembled each other in having been distant from those in which their places of employment stood, but differed in that some had furnished indigenous cases of plague or plague-rats and on that ground could be regarded as infected areas, while

others

others had not done so. Now, in the first place, there were 2 groups, which comprised 3 and 2 persons respectively, of which all the members lived in different, uninfected, neighbourhoods; the sole bond between them was resort to the 2 places at which they worked, and which stood on an infected area. Secondly, there were 10 work-places at which 28 persons were attacked in groups of from 2 to 4 persons at each; 14 of them did, while the other 14 did not, reside in infected neighbourhoods, and each of the 10 groups included representatives of both kinds of neighbourhood. As to the 14 who lived in uninfected neighbourhoods, there was no other bond between them and the remaining 14 than resort to the same work-places; as far as they were concerned there seemed to be no room for doubt that they were infected at their places of employment and nowhere else. That being so, no reason appeared for preferring the supposition that the other 14 had become infected in some untraceable way in the infected neighbourhood in which they dwelt, rather than at the work-places which had certainly been the source of infection for the 14 first-mentioned. Lastly, 5 work-places furnished groups of 2 each, of which groups both members resided in infected neighbourhoods; from them, taken by themselves, nothing to the present purpose could be inferred. They were included in the table because it was intended to exhibit frankly all known facts of the class under examination; I now maintain them there partly because the evidence afforded by the 12 groups already analysed was so nearly demonstrative; partly, also, because the expression "infected neighbourhood" was intended to, and did, represent a mere chance which was mentioned as a precaution against omission of a circumstance of possible importance, rather than any probability of efficient infectivity towards the persons now referred to. It will appear presently, indeed, that a neighbourhood or area is not infective in general, but only in virtue of particular buildings which are infected and which stand upon it. Similar observations were recorded in 1902 (Report, 1902, par. 209, Table XXIII), though in smaller number, as well as in 1903; they had more apparent (not real) weight from the greater fulness with which the details were described. Thus the data recorded in 1900, 1902, and 1903 resembled those now recorded of 1904, and the third conclusion drawn from the experience of 1900 (Report, p. 41) is now seen to have been fully corroborated by the results of further observation during those later outbreaks. This was that the infection was associated with localities.

39. What was the nature of the association between the infection and localities in which it had been shown to exist by attack of persons who had resorted to them, but who were ascertained to have been dissociated from each other under every other aspect? The infection is living; it must be present, therefore, in or upon something which not merely permits it to survive, but enables it to flourish, for it must otherwise be confined to the spot whereon it was first deposited, which, of course, does not happen. *Quâ* localisation, its possible niduses appear to be comprised under the three headings, air, water, and soil. In the air it could not continue and, above all, could not flourish any more than other infections of like nature. By water it was not conveyed at Sydney (Report, 1900, p. 30; the reasons there given apply equally to the outbreaks of 1902 and 1904), and it is now generally agreed that by water it cannot be conveyed (*Conférence Sanitaire de Paris*, 1903, *Procès-verbaux*, p. 88; exceedingly cautious though this Conference was in expressing itself on most points, it adopted the opinion *l'eau potable ne joue aucun rôle dans la propagation de la peste* without discussion). In the earth it might live, continue, and in some sense flourish, as some members of the group of organisms which cause hæmorrhagic septicæmia (to which *b. pestis* has hitherto been generally considered to belong—the pasteurelloses) appear to do. But this has not been established for the particular micro-organism now under notice, and, without denying that it might find a place in the surface soil of cities, it must be admitted that there it would be exposed to a thousand inimical accidents. Apart from that consideration, did it grow in the soil it would probably persist in it. But the association between place and the infection at Sydney was not persistent. The uniform experience of 4 outbreaks has been that the most ordinary processes of scavenging and cleansing sufficed to banish it at once and for all.* On the whole, the observed phenomena indicate that the suggestion of association between the infection and the soil in relation to attack of man is unpractical (Cf. Reports, 1900, p. 40, or 1902, par. 263). 40.

* From Table V. (pp. 20, 21) it appears that some areas have become infected more than once. It is pointed out that the names which indicate them are those of extensive municipalities, and that the reinfection did not occur in the neighbourhoods previously attacked.

40. Yet cases did recur in certain localities after rather long intervals. Of the 9 places of infection recorded in 1904, 7 were situated on an area which had yielded indigenous cases 9 months earlier (1903), 12 months before that (1902), and again 15 months before that, namely, in 1900. Were these recurrences consequential or merely accidental? On comparison of Diagram I, Report, 1902, with Diagram C, 1900, it appeared that several large areas which had yielded many indigenous cases in 1900, were entirely spared in 1902. They have not since been revisited. In 1902, again, several areas were infected during the earlier part of that outbreak, at a date when they were so widely separated from the central area on which it had begun by uninfected tracts which for the most part were covered with houses, that they were plainly entitled to be regarded as seats of distinct sub-epidemics; these also have not been revisited during the 3 years since elapsed. One of those sub-epidemics, which under this aspect was complete, may be specially mentioned; I mean that distinguished as the Paddington sub-epidemic (Report, 1902, pars. 88–96, and Diagram III). The small area on which it occurred was completely isolated from any other which was then, or which previously had been, invaded; it measured only 16 acres, had 163 buildings, and carried 8 cases which occurred in 6 houses during 32 days. No special treatment was accorded to it, yet the disease has not recurred upon it. Thus it appears most probable that the 7 places of infection which occurred in 1904 on that central area which had been previously visited 3 times did not necessarily do so in consequence of those earlier visitations, for other areas to which reference has just been made were finally rid of the infection by the same measures as were applied to it. Plague is not communicated to the soil; the soil does not communicate it to man; association between a locality and the infection is a transient condition.

41. But perhaps the territorial subdivision indicated by the word "area" is too extensive. The ground on which areas have been regarded as infective has been (so far) the occurrence somewhere upon them of cases in man. At all events, then, the investigation can be carried a little further; for if any one fact of importance has been brought out more clearly than another in the course of this inquiry, it is that the infection of man has been contingent, for the most part, on his being within buildings of some sort. And therefore, although nothing has appeared which points towards infection of the surface soil, it is yet possible that the "soil" (earth, dust, surfaces of inanimate bodies, &c.) within buildings may have proved a suitable nidus for the bacillus, which may have persisted in it from outbreak to outbreak. This point has already been fully discussed in the light of experience (Report, 1902, pars. 36–44, and Diagram I). In the first place it was shown that of the 221 houses which had been adjudged to be places of infection in 1900, 215 were spared in 1902, although a majority of them stood on the same area as was invaded in the latter year. Secondly, out of 86 houses which were adjudged to have been places of infection in 1902, 80 were in that year infected for the first time. To take another aspect of the matter, 286 houses merely harboured cases in 1900 (a statement which disregards the place of infection, and takes cognizance only of the presence of cases in the houses); only 8 of them again harboured cases in 1902. But even of those 8 only 4 were adjudged places of infection in both years. Although 2 were regarded as places of infection in 1902, the patients they harboured in 1900 were then considered to have been infected elsewhere; while the remaining 2, adjudged to have been places of infection in 1900, could not be so regarded in 1902. No evidence of place-infection, by which is meant extra-corporeal persistence of the infection in efficient form during more or less long periods of time, has been revealed, therefore, by the data concerning infected houses, just as none was revealed by those concerning infected areas. The connection between the infection and individual houses is as transient as that between it and areas. But renewed invasions of any area must probably lead, in course of time, to re-infection of some of the houses upon it; and this seems to be the best explanation of the apparent infectiveness of the very small minority of 4 houses in two epidemics which were separated (it is to be additionally noticed) by so long an interval as 15 months at the least.

42. By broad induction from, I think, a sufficiently large collection of data it has been shown that the infection was not communicated from the sick by direct or indirect (inanimate) agency, *that it must, therefore, have consisted in something external to man*, that it was distinctly connected with locality, and that this connection was not persistent but transient. Consequently the source of the infection for man must be looked for elsewhere. Animated nature alone remains. Now, it is notorious

notorious that rats and mice alone among animals are specially susceptible of plague, and at the same time habitually infest the dwellings of man. The sole questions, therefore, which remain to be answered are whether connection between plague cases and plague-rats can be positively established in a large majority of instances; and, if so, how the infection finds its way from the rat (to which animal, no doubt, it primarily belongs) to man.

43. The latter point has been considered in previous reports, and nothing of importance can yet be added. Inoculation through the skin is the mode of infection in bubonic and septicaemic plague which is best supported by the pathology of the disease. The suggestion that inoculation commonly results from accidental apposition between minute lesions of the skin and infectious matter deposited by animals has been considered to overlook practical considerations to the contrary (see Report, 1902, pars. 251–60, 261, and 298); the argument was cogent, based on experimental data and common knowledge, and it has not been answered. As regards possible inoculation by the flea, a good deal of circumstantial evidence has been adduced in this series of reports (Reports, 1900, pp. 23, 40, 56–7; 1902, pars. 262–71, 272–92, 293–4, 298–9), but nothing of a direct character; such direct evidence as has been offered by others both for and against that mode still stands much in need of examination on more exact lines. The infection of man by feeding—the only other mode which can be suggested with due regard to practical possibilities—is negatived, in my opinion, not only by the pathology but also by the symptomatology of the disease (as well as by other considerations; see par. 29 above).

44. As regards the former question it may be inquired, first, what were the time-relations between epizoötic and epidemic plague; and, secondly, by what feature were those areas on which the epidemic manifested itself distinguished from others, besides the occurrence of cases upon them. As to time-relations at least two points should be clearly made out—plague-cases should be met with only while plague-rats are present, and the beginning of the epizoötic should precede that of the epidemic. The record is set out in the table below :—

TABLE IV.—1900–4.

Year.	Month.	No. of Persons infected.	Rats and Mice.		Period.	Year.	Month.	No. of Persons infected.	Rats and Mice.		Period.
			No. examined.	No. infected.					No. examined.	No. infected.	
1900	January ...	1	...	...		1902	August ...	...	1,684	...	
	February ...	3	22	9			September ..	...	1,156	...	
	March ...	51	12	2			October ...	...	2,455	...	
	April ...	107	31	6	First.		November ...	...	2,177	...	
	May ...	93	48	5			December ...	...	3,108	...	
	June ...	41	36	1		1903	January ...	...	1,115	...	
	July ...	6	24	...			February ...	...	1,250	...	
	August ...	1	14	...			March ...	...	1,538	...	
	September ..	...	7	...			April ...	...	1,424	...	
	October ...	...	10	...			May ...	...	3,723	27	
	November ..	...	6	...			June ...	1	5,269	97	Third.
	December ...	...	4	...			July ...	1	4,186	23	
1901	January ...	...	1	...			August ...	...	3,087	14	
	February ...	...	21	...			September ..	...	3,196	...	
	March ...	...	16	...			October ...	...	3,232	...	
	April ...	...	9	...			November ..	...	3,045	...	
	May ...	...	1	...			December ...	...	2,414	...	
	June ...	...	1	...		1904	January ...	...	2,565	...	
	July ...	...	...	...			February ...	...	2,483	...	
	August ...	...	157	...			March ...	1	5,808	4	
	September ..	...	4	...			April ...	4	5,394	32	
	October ...	...	...	...			May ...	3	5,605	35	
	November ...	1	226	4			June ...	1	5,356	89	
	December ...	1	303	...			July ...	1	5,371	50	Fourth.
1902	January ...	6	211	5			August ...	...	4,331	6	
	February ...	26	449	25			September ..	2	4,472	20	
	March ...	57	550	6	Second.		October ...	...	3,783	5	
	April ...	20	3,023	37			November ..	...	3,238	1	
	May ...	22	3,345	23			December ...	...	3,621	1	
	June ...	6	2,397	4							
	July ...	...	2,124	1							

45. This table does not show that plague in rats always preceded plague in man. Quite at beginning of the first outbreak no adequate search for plague-rats was made, and no systematic watch was kept on the rats during the 15 months which elapsed between its close and beginning of the second outbreak. During the latter, search began only after its first case had been notified, so that the position was almost the same as in 1900, when the disease first appeared here. But the ascertained facts on both of these occasions, although they did not absolutely demonstrate precedency of the epizoötic, yet furnished very good ground for assuming it. (*a*) As soon as the nature of the first case had been ascertained (25th January, 1900), the public were requested by advertisement to report any unusual mortality or movement of rats which they might have observed. No response was made until 14th February—that is to say, during the interval of 29 or 30 days which elapsed before the second patient was attacked—when a Customs Officer drew attention to mortality among the rats at the wharf where he was engaged. On search, 3 or 4 carcases were found in which the infection of plague was identified, while wide spread of it among rats along that wharf-line was ascertained immediately afterwards; and when, several weeks later, an inspector of imported fruit in employment of the Agricultural Department mentioned that he had first noticed an unusual number of dead rats at the wharf at which he worked in the same neighbourhood, as far back as the first week of January—that is to say, before attack in the first case—no other reason for doubting his account appeared than that he spoke from memory. (*b*) The first case of the outbreak of 1902 was not notified until the 10th day of illness. It was then found that the patient's place of employment yielded 69 carcases of rats, all of which but one were so far advanced in putrefaction as to be useless for bacteriological examination; from which it was inferred that the disease had attacked the horde many days earlier. So, also, search along the Darling Harbour wharf-line revealed the presence of plague in the rats there as soon as it was begun—that is, 2 days after notification of the case referred to, and thus showed that the disease was already widely spread. (*c*) Onwards from conclusion of the 1902 outbreak a systematic and thoroughly efficient watch was constantly kept on the rats, and this resulted in establishing presence of the epizoötic both in 1903 and 1904 before any human being had fallen ill.

46. The time-relations, then, may, on the whole, be taken to have been in fact what in theory was required. If, now, we proceed to examine the place-relations, it will be found that the feature which distinguished areas on which cases occurred from others which yielded none, was the presence upon them of plague-rats. The record is set out in the next table:—

TABLE V.—1900–4.

	First Period.		Second Period.		Third Period.		Fourth Period.	
	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.
City of Sydney—								
Belmore Ward... ...	2	1	2	.....	.....	.....	.....	.....
Bligh „	2	.....	3	.....	.....	.....	.....	.....
Bourke „	26	2	8	5	1	1	.....	22
Cook „	8	.....	1	19	.....	.....	.....	.....
Denison „	12	.....	6	2	.....	.....	.....	.....
Fitzroy „	.....	.....	2	2	.....	3	.....	.....
Flinders „	4	.....	.....	.....	.....	.....	.....	.....
Gipps „	11	.....	3	4	.....	2	3	33
Lang „	77	13	13	24	1	64	4	143
Macquarie „	17	1	26	13	.....	.....	.....	6
Phillip „	14	1	12	4	.....	2	2	25
Pyrmont „	5	.....	6	5	.....	11	.....	.....
Suburban Municipalities—								
Annandale	4	.....	.....	.....	.....	.....	.....	.....
Alexandria	.....	.....	8	4	.....	.....	.....	.....
Ashfield	.....	.....	.....	.....	.....	.....	.....	.....
Balmain	.....	.....	.....	.....	.....	.....	.....	.....
Bexley	.....	.....	.....	.....	.....	.....	.....	.....

	First Period.		Second Period.		Third Period.		Fourth Period.	
	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.
Suburban Municipalities—*continued.*								
Botany	.....	.....	.....	.....	.....	.....	1	2
Botany North	.....	.....	.....	.....	.....	.....	.....	.....
Burwood	.....	.....	.....	.....	.....	.....	.....	.....
Camperdown	2	.....	2	5	.....	.....	.....	.....
Canterbury	.....	.....	.....	.....	.....	.....	.....	.....
Concord	.....	.....	.....	.....	.....	.....	.....	.....
Darlington	.....	.....	.....	.....	.....	.....	.....	8
Drummoyne	.....	.....	.....	.....	.....	.....	.....	.....
Enfield	.....	.....	.....	.....	.....	.....	.....	.....
Erskineville	.....	.....	.....	.....	.....	.....	.....	.....
Glebe	6	.....	.....	.....	.....	.....	.....	.....
Hunter's Hill	.....	.....	.....	.....	.....	.....	.....	.....
Hurstville	.....	.....	.....	.....	.....	.....	.....	.....
Kogarah	.....	.....	.....	.....	.....	.....	.....	.....
Lane Cove	.....	.....	.....	.....	.....	.....	.....	.....
Leichhardt	1	.....	.....	.....	.....	.....	.....	.....
Manly	10	3	.....	.....	.....	.....	.....	.....
Marrickville	.....	.....	.....	.....	.....	.....	.....	.....
Marsfield	.....	.....	.....	.....	.....	.....	2	4
Mosman	.....	.....	.....	.....	.....	.....	.....	.....
Newtown	.....	.....	1	12	.....	.....	.....	.....
North Sydney	.....	.....	.....	.....	.....	.....	.....	.....
Paddington	20	.....	9	3	.....	.....	.....	.....
Petersham	.....	.....	.....	.....	.....	.....	.....	.....
Randwick	.....	.....	.....	.....	.....	.....	.....	.....
Redfern	25	2	1	1	.....	.....	.....	.....
Rockdale	.....	.....	.....	.....	.....	.....	.....	.....
Ryde	.....	.....	.....	.....	.....	.....	.....	.....
St. Peters	.....	.....	.....	.....	.....	.....	.....	.....
Strathfield	.....	.....	.....	.....	.....	.....	.....	.....
Vaucluse	.....	.....	.....	.....	.....	.....	.....	.....
Waterloo	10	.....	10	2	.....	80*	.....	.....
Waverley	3	.....	.....	.....	.....	.....	.....	.....
Willoughby	.....	.....	.....	.....	.....	.....	.....	.....
Woollahra	6	.....	.....	.....	.....	.....	.....	.....
Totals	265	23	113	105	2	161	12	243

47. Again the evidence regarding the first year is defective; it suggests that in 1900 plague occurred independently of infected rats, for many districts yielded cases rather freely from which, as it appears, no plague-rats were gathered. But failure to collect plague-rats is not ground for asserting that none existed, nor even that none could be found.

It might be thought that this point hardly could escape attention; yet it is not unnecessary to mark it. For, during the proceedings of the Technical Sub-committee of the Paris Conference, 1903, one of the delegates of Great Britain cited the cases of Glasgow (first outbreak) and of Liverpool in proof of his assertion that plague in man had occurred in places where it appeared that the rats were unaffected (Discussions: pp. 354-5). Nocht (Germany) raised the logical objection that it could not be concluded that plague-rats were absent merely because none had been found; and he descanted on the difficulty often met with in detecting them (on which I have myself had occasion to remark at length; *see* Report, 1902, par. 114 *et seq.*), even within the restricted area of a vessel. It sufficed for the occasion, but it might well have been enforced by reference to the extent of the search made. This was quite inadequate. Thus at Glasgow, "from the end of August till the middle of November, 236 rats were caught within the plague area—mostly in the neighbourhood of infected houses—and no trace of the disease was discovered in any of them." The duration of the search was apparently about 75 days; the number of rats examined was equal to a rate of about 3 a day. "Most" of them, not all, were gathered in the neighbourhood of infected houses; none were got from the infected houses themselves (Report on Cases of Plague occurring in Glasgow in 1900: by A. K. Chalmers, M.D., Medical Officer of Health, August, 1901, p. 86). Again, at Liverpool, where the first identified cases of plague were encountered about 23rd October, 1901, "the total number of rats which were examined from October to December was 150. In no case was any rat found to be infected with plague" (Report on the Health of the City of Liverpool during 1901: by E. W. Hope, M.D., Medical Officer of Health, p. 169). Doubtless the transactions of an international sanitary conference, whose members are largely preoccupied with political considerations, are not, speaking generally, the best authority on scientific questions; yet the President of the Technical Sub-committee (Commendatore Rocco Santoliquido, Italy), in which the remarks under notice were made, had formally declared that the Sub-committee was concerned solely "*d'une mise au point des notions acquises,*" (p. 228). And therefore it may be regretted that the delegate referred to should have seen

* Gray's stables, 78; the yard of a neighbouring factory, 1; a street, 1.

seen fit to support his argument, "that the danger from rats is not so great as has been supposed," by the still more illogical citation of the case of Cardiff, in which no man suffered, although plague was present in the rats. Delegates of France (Proust, Brouardel, Roux, and others), and of Germany (Gaffky, Nocht), as well as those of some other Powers, were at one in declaring that the danger from rats was much greater than from man, and even in regarding it as the only danger to be seriously reckoned with; a view which I have advocated in and from the year 1900, solely on grounds furnished by direct observation. That the danger referred to has not in practice been seen to take effect quite so often, perhaps, as might have been expected *a priori*, but that it is, nevertheless, the only danger run as regards the dissemination of plague oversea, appears to me to be a more exact statement than that quoted above.

But discussion of the particular question (whether plague is spread oversea by plague-rats, or otherwise) is somewhat beside the point; and it is needless to do more than mention the narrowness and inexactness of such statements as, that rats are the chief means of diffusion by sea (as distinguished from diffusion on land) or, that rats are the chief means of starting epidemics in clean places, but afterwards man becomes the chief agent in continuing them. What it is necessary to learn is whether plague owes it dissemination essentially to the rat, for thus every contingency into which plague-rats enter, or may enter, is contemplated. The view entertained by English writers on plague in India and in China is that the rat is not an essential factor in epidemics; and in the following sentence, which occurred in the Report of the Indian Plague Commission, sec. 277, the reason happens to have been very clearly given, as follows:—"It is, however, important to note that the outbreak of plague among rats has not, in all cases, been followed by occurrence of plague among men, and that explosive outbreaks have sometimes been due to causes other than spread of the infection by rats." The first of these two statements may be correct, no doubt, but its bearing on the discussion is not plain. It is not antithetical to the second statement, although the construction of the sentence makes it appear so; it stands by itself as an observation of the negative order, and, as such, is open to explanation by circumstances which in no way touch the capability of rats to spread plague, and the share therein taken by them. The second point is of a quite different character; it purports to be a fact. Whether it is so is matter of evidence. Now, while it is patent to those who have compared the epidemiological sections of the Report with the testimony on which they were based, that they derived very much of their force from the manner in which that testimony was represented in them, it is also very difficult to find anything laid before, or elicited by, the Commission, either for or against the agency of rats, which can be called "evidence," even on the most liberal interpretation of the word. Omission of an epidemiologist from the constituent members of this Commission was an oversight which seems likely to have far-reaching consequences in India.

48. The record of the first period shows, indeed, that plague was identified only in 23 rats in all. The smallness of this number was due in part to the plan of record which was then adopted, and which has since been adhered to. This was to confine the term "plague-rat" to those animals in which presence of the disease had been bacteriologically demonstrated (*Cf.* Reports, 1900, p. 39; 1903, par. 13). If findings of putrid carcases in numbers during progress of an ascertained epizoötic of plague had been taken—as, no doubt, they fairly might be taken—as valid evidence of death from plague, the strictly accurate record of the first column of the table would have assumed a very different complexion from that it actually bears. But, secondly, it was soon perceived that the meagre resources at command during that year, and the necessary concentration of attention on the then most important question whether epidemic prevalences were due to communication of the infection from the sick, would prevent the rat-search from being thoroughly carried out. However, nothing appeared to prevent a systematic attempt to carry it far enough to define the area over which the epizoötic extended; and this was done with the result of showing sufficiently clearly that the epizoötic area and the epidemic area were practically conterminous (*see* Report, 1900, Diagram B). From the Diagram just referred to it will be perceived also that the rats, which in Table V are ascribed to a particular district which there appears out of all connection with any other, may well have occurred on its border-line, and, consequently, effectively near to some district which has been entered as having furnished cases but no rats. The complement of these negative observations is furnished by the three succeeding columns of the table. In 1902 the conditions of the rat-search were much improved, and in the remaining two years became very complete; it appeared, consequently, that plague-rats could be found always on areas which yielded indigenous cases. On such areas, however, plague-rats were found in some occupied buildings which, nevertheless, yielded no case in man; sometimes, also, a whole area which at some part carried plague-rats, furnished no case in man. But such facts, frequently observed elsewhere in the case of ships, do not show that plague-rats are not the cause of plague; they show only that apparent exposure is not always effective exposure, and—as I have so often pointed out—that several circumstances which do not commonly concur are necessary to communication of the disease from rat to man.

49. So broad a local association, however, might be merely coincidental nevertheless; in order to ascertain whether it had that character it must be more closely examined. Let the localities with which Case H, and Cases L and M, were

respectively

respectively connected be first considered. These places were remote from the focus (or Darling Harbour area), and they were still further removed from each other, for while one stood about 6 miles to the south, the other stood at a rather greater distance in a northerly direction. They were thus isolated from the focus and from each other by very wide tracts, which were covered with houses in numbers which diminished gradually as distance from the focus increased, and which yielded neither cases nor rats. Local infection under such conditions is a point of so much importance that it is necessary to quote the two following paragraphs from the Report of 1902, in order to show that in these instances it was not at all exceptional :—

238. From some part of each of the 8 wards* into which the city proper is divided (total area, 2,880 acres; number of houses, 21,137), all of which yielded cases, and from some part of each of those 6 of the 40 municipalities comprised in the metropolitan district which yielded cases of plague, plague-rats were collected. No plague-rats were got from districts in which no indigenous cases occurred. Neither were any got from districts into which cases had been merely imported; the extent to which the search was carried in such districts is shown in the sixth column of the preceding Table.

239. With assistance of the details already given (*see* Mode of Spread, p. 18), the general indication afforded by this Table can be supported a little more directly. Thus, although Alexandria and Waterloo have a combined area of 1,830 acres, which carries 3,947 houses, the findings of plague-rats were confined exactly to those neighbourhoods in which the cases of plague were found; or, although Paddington has an area of 403 acres, which carries 4,386 houses, plague-rats were found only on that very small part (of about 16 acres, carrying 163 houses) which has been named the Paddington area, where the 9† (or 11) cases which constituted that sub-epidemic were found. Again, Camperdown covers 435 acres, and carries 1,503 houses, but plague-rats were identified only at premises in that street where the two indigenous cases of plague were met with. So also at Newtown, where the municipality covers 442 acres, and contains 4,521 houses, the only case of plague which happened there was found within half-a-dozen doors of the butcher's where a local manifestation of the epizootic occurred, and at the same date. There is good evidence, then, of close association in place between plague cases and plague-rats.

50. Clearly some special circumstance must have led to occurrence of the disease in Case H and in Cases L and M on those remote and isolated areas; and if it be asked what that circumstance was, it can be replied at once that it was the presence upon them of plague-rats, since this alone distinguished them from very extensive tracts of town land which entirely surrounded them. The reason why these two distant places carried plague-rats can also be assigned, for it is known that goods of particularly dangerous kinds were transported from infected premises at the focus to each of them. Thus the matter seems clear beyond reasonable doubt. The association between plague in man and plague in rats which has been observed to be localised on comparatively small areas, and to be confined to them, is not coincidental, but is that of cause and effect. The criterion by which infection both of areas and of buildings is to be decided in general, therefore, is presence of the disease in the rats which infest them, not in the persons who inhabit them.

51. When the form in which the infection reached these distant localities is sought, doubt begins. Plague-rats have not been detected in goods carried, or in course of being carried, to a distance by land, although, of course, rats have been commonly seen to be so carried; but plague-rats have been observed on two ships (the s.s. "Antillean," Report, 1902, pars. 50–65, and the barque "Alsterschwan," Report, 1903, par. 24). Might it have been merely deposited by plague-rats at the focus on rags, old bags, &c., and on chaff, and so have been communicated to the rats at the paper-mill and at the private residence? Perhaps; yet in view of considerations which have now been sufficiently indicated, I think not. Had the agency of the flea been removed from the region of hypothesis by the results of sufficiently numerous direct experiments, that would be as likely a form of conveyance as any other; but this has not yet been done. Actual transport of plague-rats appears to me to be the best supposition.

52. This is a convenient place at which to point out that the infection cannot have reached the premises on which the cases L and M occurred less than thirty-six days before attention was drawn to disease among the rats by attack of L, and may have been conveyed to them much earlier. I have many times pointed out that presence of plague-rats has often been observed not necessarily to entail attack of man on premises on which they have been found, and that when the infection has taken effect on man usually only a few of all those apparently

* Now 12.

† This number has been given as 8 in paragraph 40. The sub-epidemic consisted in 9 cases; but the sub-epidemic area carried 8 of them only, for the ninth was that of a workman who was infected upon it but who lived and lay ill at a considerable distance.

apparently exposed to it, and most usually but one of them, have suffered. And just as all in the neighbourhood of plague-rats are not attacked, so those who are to suffer do not do so as soon as they come into that neighbourhood (for another example see Case A above). This latter observation has been made by others, and often, I think, has been misinterpreted. Such an interval means nothing, in my opinion, except that the lengthy chain of circumstances on which I have so often remarked, and which seems to be necessary to infection of man, is not easily completed under the conditions which usually obtain in civilised communities. The interval which elapses between the first appearance of the disease in rats and commencement of it in man is sometimes short, sometimes long. I believe the fact to be that the necessary conjunction between several coexistent, but insulated, conditions is not brought about until instances of those conditions have so multiplied that the chances against it here and there fail altogether, and conjunction occurs. This also seems to be the explanation of the erratic incidence of the disease on persons who seem to have been equally exposed to an infection which finds in man so congenial a soil that if taken it almost always flourishes in him and, very often indeed, overcomes all his resistance speedily and kills him (on this point see also Report, 1902, par. 299).

53. But if the inference of causativeness which, I think, may be drawn from the peculiar features of the observed association between cases and plague-rats on areas be just, it should be capable of corroboration by tracing it more particularly, and by showing that it existed, not merely in relation to areas, but in relation to the individual houses in which cases occurred. As soon as the attempt to do this was made great difficulties were encountered, which have already been described at length (Reports, 1902, par. 22; 1903, par. 13); they attached in part to the search-conditions, and in part to the habits of rats. In practice it is not easy to find plague-rats; it is equally difficult to find their carcases in a state of preservation in which the presence of plague in them can be demonstrated. To overcome these obstacles was the special object kept in view during 1904.

54. The kind and duration of association with plague-rats discovered in the twelve cases has already been given above in detail, along with other particulars concerning them; but the following summary will, perhaps, make these points clearer. The word "focus" is used to indicate all that central part of the city over which infected rodents were gathered (*see* Diagram); for the value of the expression "remote from focus" reference may be made to the notes of each case (*see* paragraph 20).

A.—Attacked 9th March. Employment, at focus; had handled dead rats on three days, ending 3rd March; during search after attack 11th March, dead mice found and plague identified in them. Residence distant from focus; no signs of infestation.

B.—Attacked 10th April. Employment, at focus (Grafton Bonded Stores); at one or other of the collection of separate buildings at which B worked plague-rodents were identified as follows:—1st March, 14th, 18th, and 20th April (on the adjoining wharf), 27th April, 14th and 31st May. Residence distant from focus; no signs of infestation.

C.—Attacked 20th April. Employment, near focus; a plague-rat had been identified 19th April, and others were identified during search at time of notification. Residence distant from focus; no signs of infestation.

D.—Attacked 22nd April. Employment, at focus (Wearne's Grist Mill); plague-rats identified on search, after notification, 27th April to 5th May. Residence remote from focus; no signs of infestation.

E.—Attacked 25th April. Employment, near focus; no dead rats found, no plague-rat identified; but on 22nd April had loaded goods at Grafton Wharf, whence plague-rats had been taken on 14th, 18th, and 20th April (see B, above). Residence not far from focus; no signs of infestation.

F.—Attacked 8th May. Employment, at focus (member of cleansing gang); plague-rats identified at D's place of employment (Wearne's Grist Mill, see D, above) which F had helped to cleanse between 28th April and 5th May. Residence at focus; no signs of infestation.

G.—Attacked 25th May. Employment, at focus; plague-rats identified before attack, G. having handed in two dead rats on 24th and 25th May, as well as afterwards during search. Residence separated by water from focus; no signs of infestation.

H.—Attacked 31st May. Employment, remote from primary focus; plague-rats identified on search after notification, 10th to 23rd June. Residence remote from primary and from this secondary focus; no signs of infestation.

I.—Attacked 19th June. Employment at focus; no signs of infestation. Residence at focus; plague-rats identified 14th June, many putrid carcases found on search afterwards.

K.—Attacked 31st July. Employment at focus; plague-rats identified on search after notification, 4th to 8th August. Residence, remote from focus; no signs of infestation.

L. and M.—Attacked 7th and 10th September. Residence, remote from primary focus; on search after notification, dead rats found and plague-rats identified 12th to 16th September.

55. Thus close association with plague-rats was shown to have existed in every one of the series of cases which constituted the outbreak under review; and given an experienced staff and the requisite leisure, I see no reason for doubting that a similar result would be generally attained. But neither directors nor staffs can, as a rule, afford to give the necessary watchful attention from day to day to each case as it arises, nor spare time for lengthy enquiries into details; yet these must always be indispensable conditions of success. Even when they have been fulfilled, the result can rarely be complete. In any considerable series of investigations of the kind defects must occur from time to time; and, indeed, one such was met with last year, when a minute enquiry appeared to exclude every source of infection in Case A (Report, 1903, par. 19). But no one accustomed to epidemiological work would lay much stress on negative observations of that class after having given them due consideration, as long as they remained in a proportionately small minority.

56. I am now able, therefore, to redirect attention to the eleven deductions which I drew from the first outbreak, and to point out that they remain substantially unaltered. They represented the main features of epidemic plague at Sydney quite correctly; and as in these days mere speculative opinion tends more and more to overlay the results of observation, and the chronology of events in any case is likely to be overlooked, I shall be excused, perhaps, if I remark that the total inefficiency of communication with the sick as a cause of epidemics of bubonic and of septicæmic plague, together with its all-important corollary that the source of infection must exist quite outside, and independently of, man, was first established five years ago in my account of the outbreak of 1900, on evidence which was furnished by a sufficiently long series of cases. The deductions referred to were the following:—

1. *The disease was not directly communicated from the sick to the well—in other words was not "catching."*

2. *It was not communicated in any important degree, at all events, from the sick to the well by mediate channels (clothes, household goods, merchandise, excreta).*

3. *The infection attached to localities, and spread to others adjoining and continuous with that in which it was first manifested.*

4. *It also spread in a fashion which betokens the possibility of its being transported mechanically from an existent focus to a considerable distance, and there initiating an independent focus.*

5. *In the buildings in any infected locality cases occurred irregularly, and showed no special proneness to occur in adjoining houses.*

6. *When the occurrence of one case among the inhabitants of a building showed that the infection was present in it, secondary cases rarely followed. Irregularity of incidence on houses was accompanied with irregularity of incidence on the inmates.*

7. *An epizoötic disease among rats preceded the first case which occurred in man.*

8. *This epizoötic disease was plague.*

9. *The area over which the epizoötic extended was practically coextensive with that on which cases of plague in man were observed.*

10. *The epizoötic died out as far as can be learned at the same time as the epidemic ceased.*

11. *The epidemic was caused by communication of the infection from rats to man.*

57. The aetiology of plague must be essentially the same everywhere. Individual cases of an inoculable disease may have their origin in many different circumstances, but epidemic prevalences must be due to similar causes wherever they may occur. The behaviour of the intermediary between rat and man, which latter though still hypothetical is also still indispensable, may give rise to slight variations; but these, when they come to be fully understood, will be found to have been apparent rather than real. The rat is the *fons et origo* of infection. That this view should speedily receive support from further exact observations recorded elsewhere is not to be expected. In many other countries where plague exists, conditions of race and creed, of customs and civilisation, of housing, morals, and instruction, notoriously have rendered accurate and complete epidemiological observation impossible; save, indeed, when the conditions of search have been

entirely

entirely under the investigator's control, and when completeness of result has depended solely on his personal energy. No doubt this is the case sometimes as, for instance, with malaria under some of its aspects; but it is not so with plague. The evidence which has been adduced in this series of Reports began to be collected originally under very advantageous conditions, which have improved with experience and with better instruction of the public in this particular connection; the record is as accurate, and—a not less important point—as complete as the nature of such enquiries leaves possible. I point to it, therefore, as showing that the view mentioned holds good at Sydney; and I suggest that what is constant in one large city must probably have general application.

J. ASHBURTON THOMPSON.

[One plan.]

Sydney: William Applegate Gullick, Government Printer.—1905.

PLAGUE REPORT, 1904.

Table showing the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken. References to the twelve cases are inserted in the series in their order, according to date of attack.

No.	Place.	Rodents taken. Total.	M. Mus.	M. Rat.	M. Bus.	First.	Last.
1	Grafton Bonds, Sussex Street	4	1	1	2	1-3-4	27-3-4
	Case A, attacked 9.3.4.						
2	161 Sussex Street	1	—	1	—	8-3-4	8-3-4
3	151 Sussex Street	2	—	—	2	17-3-4	17-3-4
	Case B, attacked 10.4.4.						
4	Grafton Wharf	3	3	—	—	14-4-4	20-4-4
5	Reid's Store, Belmore Markets	24	24	—	—	19-4-4	20-4-4
	Case C, attacked 20.4.4.						
	Case D, attacked 22.4.4.						
	Case E, attacked 26.4.4.						
6	Weaver's Mills, Dixon Street	4	—	2	2	27-4-4	3-5-4
7	18-22 Campbell Street	1	—	—	1	30-4-4	30-4-4
	Case F, attacked 8.5.4.						
8	S.S. "Illawarra," Market Wharf	5	5	—	—	10-5-4	11-5-4
9	17 York Street	2	2	—	—	11-5-4	12-5-4
10	A.U.S.N. Wharf, Nos. 4 and 3	4	2	1	1	12-5-4	24-5-4
11	227 Sussex Street	1	1	—	—	16-5-4	16-5-4
12	257 Sussex Street	2	—	—	2	20-5-4	20-5-4
13	235 Sussex Street	1	—	—	—	23-5-4	23-5-4
14	46 City Road, Darlington	2	2	—	—	24-5-4	26-5-4
	Case G, attacked 25.5.4.						
15	Federal Wharf, Bond Yards and Stores	28	11	9	8	25-5-4	29-5-4
16	Dalgety's Wharf (Old), No. 1	12	2	6	4	25-5-4	26-5-4
17	Tone's Wharf	4	3	—	1	28-5-4	14-6-4
18	45 City Road, Darlington	6	6	—	—	28-5-4	29-5-4
	Case H, attacked 31.5.4.						
19	7 Wharf Street	11	—	5	6	7-6-4	9-6-4
20	123 Sussex Street	9	—	2	7	7-6-4	12-6-4
21	Federal Poster Mills, Botany	2	—	1	1	10-6-4	10-6-4
22	5 Wharf Street	1	—	—	1	10-6-4	10-6-4
23	H. Parker's Wharf (Goods)	1	1	—	—	10-6-4	10-6-4
	Case I, attacked 19.6.4.						
24	9 Wharf Street	63	1	43	19	14-6-4	2-7-4
25	Union Wharf Druitt Street, No. 2	7	—	1	6	6-7-4	6-7-4
26	129 Sussex Street	4	—	—	4	11-7-4	11-7-4
27	Union Wharf	1	1	—	—	20-7-4	20-7-4
28	Goldsbrough, Mort's Store, Circular Quay	27	27	—	—	23-7-4	30-7-4
	Case K, attacked 31.7.4.						
29	170 Clarence Street	3	—	—	3	4-8-4	8-8-4
30	Dalgety's Wharf (New), Nos. 2, 3, and 1	4	3	—	1	22-8-4	23-8-4
31	152 Sussex Street	2	—	1	1	22-8-4	23-8-4
32	Harbour Trust's Lumber Yard	1	1	—	—	3-9-4	3-9-4
	Case L, attacked 7.9.4.						
33	61-63 Sussex Street	2	—	—	1	8-9-4	8-9-4
34	Dalton's Wharf, No. 1	1	—	—	1	12-9-4	12-9-4
35	59 Sussex Street	1	—	—	1	9-9-4	12-9-4
	Case M, attacked 10.9.4.						
36	"Curzon Hall," Belvidere Road, Marrickville	4	—	3	1	13-9-4	17-9-4
37	408 George Street	2	2	—	—	14-9-4	20-9-4
38	350 Sussex Street	2	—	—	2	15-9-4	15-9-4
39	Dalgety's Wharf, Nos. 1 and 2	4	2	—	2	24-9-4	11-10-4
40	Cellar of Sydney Arcade, George Street	4	4	—	—	29-9-4	4-10-4
41	360 Sussex Street	2	2	—	—	10-10-4	10-10-4
	Totals	243	108	73	62		

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHEWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1904, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place ..... (letter thus .....) ● 22

Places at which persons who had plague were employed ..... (letter thus .....) A

Do. do. do. resided ..... (letter thus .....) ◎

Boundaries of the Wards into which the City proper is divided .....

GIPPS WARD

BOURKE WARD

LANG WARD

MACQUARIE WARD

FITZROY WARD

PYRMONT WARD

DENISON WARD

PHILLIP WARD

BLIGH WARD

GIPPS WARD

COOK WARD

FLINDERS WARD

J. Cullen, Government Printer, Sydney.

7th July, 1905.

6 miles West

9 miles West

11 mile East

4½ miles South

57944