

in which the flea population was abundant and was kept up by a natural supply from the roof: it was much slower in Experiment VII, go-down No. 5, in which the flea supply was kept up artificially; and, finally, it was slowest of all in go-down No. 6, Experiment VI, in which there was no definite natural supply of fleas, and from which the fleas were daily removed for a period of six days, after which removal only a comparatively small number could be caught.

(4) An epizootic of plague may start without direct contact of healthy animal and infected animal. Thus, in the case of Experiment V in go-down No. 1 the healthy guinea-pigs were not put in until the last inoculated guinea-pig had died and been removed.

(5) We have in Part II shown by direct experiment that the rat flea can convey plague from rat to rat. Further experiments (Experiments VI, VII and XI) of a similar nature with the fleas removed from infected go-downs are now recorded.

(6) Infection can take place without any contact with contaminated soil. Thus in go-downs Nos. 1 and 2 (Experiments VIII, IX), guinea-pigs placed in wire cages two inches above the ground developed plague; also the monkey in go-down No. 2 (Experiment XIII) was never in contact with the ground.

(7) Aerial infection is excluded. Thus, guinea-pigs suspended in a cage two feet above the ground did not contract the disease, while in the same go-down those animals allowed to run about and those placed two inches above the floor became infected. Further, the monkey surrounded by tangle-foot was exposed as much to aerial infection as the control animal which contracted the disease.

PART IV.

EXPERIMENTS IN PLAGUE HOUSES IN BOMBAY.

We have definitely shown above that the infection of plague can be conveyed from animal to animal by means of the rat flea. We now propose to detail some observations which go to prove, both indirectly and directly, that in a plague-infected house the infection may be due to the presence therein of rat fleas, which are capable of transmitting the disease to animals.

In choosing the houses for our present purpose we took a certain amount of care to ensure that they were really plague infected. Thus for the most part only those rooms were used in which two or more

people were suffering from the disease, or in which rats infected with plague had been found, or in which there was a history of dead rats having been discovered. While, then, there is a presumption that in every case the house really did contain the infection of plague, it is not by any means certain that this was so. For with the disease so widespread throughout Bombay it is of course possible that two cases found suffering or dead in a room may both have received their infection elsewhere. It is also possible that the infection may have been got in the passages of the buildings or in another room of the building, for it is not an uncommon practice among natives immediately to vacate a room in which two or three people have become attacked and occupy another room of the same building. Further, it is possible that the rats which were found dead and not examined may not have died from plague. This is all the more likely as at the time of the present epidemic a vigorous poisoning crusade against rats was being carried on by the Health Department of the Municipality. In some cases there was absolutely no doubt about the house being infected, while in the case of others the above possibilities must be kept in mind.

These observations may be conveniently divided into three groups of two series each, and the results of each series recorded in separate tables, numbered I to VI.

Before we proceed to draw attention to each of these groups *seriatim*, it is well to state that a careful post-mortem examination was made of every animal which died. The naked eye post-mortem appearances were first recorded; then smears of the spleen, of the heart-blood and of the bubo, if present, were stained and examined. Finally, cultures were taken from the organs and from the heart-blood. These cultures were tested as to their appearance on agar and as to their power of forming involution forms on salt agar and stalactites in oil broth. Further, subcultures of every strain were inoculated into a number of wild Bombay rats, which rats were examined post-mortem for signs of plague and for the presence of the plague bacillus in smears of the spleen. Working systematically in this manner we found it easy to make certain of plague-infected animals and to exclude deaths from intercurrent diseases, which, however, occurred extremely rarely.

GROUP I.

In the observations comprised in Group I guinea-pigs were allowed to run about free for from 18 to 40 hours in houses selected as we

have described above. This technique was devised by Captain Liston, I.M.S.¹, before the present Commission began work.

We have already shown that guinea-pigs may live in contact with plague-infected animals, run about on floors contaminated with the urine and faeces of these animals and eat food similarly contaminated and still not contract the disease, if fleas are excluded. But if fleas are present, then they readily become infected. We shall also show below (Paper VII, p. 518) that guinea-pigs may run about on floors grossly contaminated with virulent plague cultures and still not contract plague, if the floors have been allowed to dry for from 12 to 24 hours. In our present experiments, therefore, we are indirectly led to the conclusion that if any of these free guinea-pigs contracted plague it might be due, not to contaminated floors, but possibly to fleas infected from plague rats. This conclusion receives support from the fact that rat fleas, as we shall see, were readily caught in considerable numbers on the animals.

For the purpose of the present observations a differentiation between human, rat and cat fleas was made. For this differentiation the following points were attended to:—

1. The presence or absence of prothoracic or suboral comb of large bristles.
2. The shape of the head and the arrangement of the bristles thereon.
3. The shape and size of the claws.
4. The number and relative length of the antipygideal bristles.
5. The form of the claspers in the male and the ovipositors in the female.

There are two series of experiments in this group, namely Series I, in which the rooms were not disinfected before the guinea-pigs were put in; and Series II, in which disinfection by the ordinary methods had been carried out just before the animals were set free in the room.

SERIES I.

Experiments with guinea-pigs running free in plague houses which had not been disinfected.

The results of this series of observations are detailed in Table I, p. 482.

The first point which comes up for remark is the number of fleas

¹ *vide supra*, p. 430.

caught on the guinea-pigs. The method of performing this operation was as follows. The animal was put in a glass jar, in which a small piece of cotton-wool soaked in chloroform had been placed. When it had become fully anaesthetised it was taken out, shaken and combed with the fingers over a sheet of white paper. In this way a great number of the fleas, which were also under the influence of the chloroform, was dislodged. The hair was then thoroughly searched for any fleas which might remain. Fleas which had fallen off while the animal was in the jar were also recovered. Working in this way we made a careful count of the fleas in every observation. A glance at the table will show that in several instances a large number was obtained, the average number per house being 20. It is important to note that the great majority of the fleas caught in this way were rat fleas.

The second point to which we have to draw attention is that, out of forty-two experiments, twelve houses (29 per cent.) proved infective for one or more of the guinea-pigs which had been placed therein, the animals dying of plague within a few days after they had been removed from the house. Of the 18 experiments in which more than 20 fleas were obtained, 9 (50 p.c.) gave positive results. It is important to record that in practically all these guinea-pigs the situation of the primary bubo was in the cervical region. Thus, out of seventeen post-mortems it was noted that in sixteen instances the bubo was in the cervical region alone, while in the remaining case multiple buboes in the axillary and cervical regions were observed.

A detailed reference to one or two of these observations will perhaps conduce to a better understanding of the general nature of the present observations.

Nos. 9 and 10. 19 *Dukerwadi*. This house was one of three floors. On the ground floor there resided a family who sold milk, the cows, however, not being kept on the premises. The first floor was used as a club for Goanese servants who were out of employment. It consisted of a large room in front and two smaller rooms at the back, separated from one another by a narrow passage. All these rooms were fully occupied, the total inhabitants of the club averaging about 30. The second floor was a loft underneath the tiles, which were of country make and offered good shelter for rats. This loft was not occupied.

On 3. ii. 06 it was brought to our notice that during the previous two days five cases of plague had occurred amongst the Goanese on the first floor. Three of these had already died and the other two had been removed to hospital. The inhabitants, who were more or less panic-

stricken, denied having found dead rats, but rats, which had been proved at the laboratory to be plague infected, had been found in the gully alongside the house.

On 3. ii. 06 two guinea-pigs were allowed to run free in the large room in front and on 4. ii. 06 two others were put into the back rooms. Between 4. ii. 06 and 6. ii. 06 two more plague cases occurred, both of which died. The house was now completely evacuated. On 5. ii. 06 the first two guinea-pigs were examined and yielded 77 fleas, which fleas were transferred to two white rats in the laboratory. The guinea-pigs were removed and segregated. Both the guinea-pigs and one of the white rats died of plague. On 6. ii. 06 the other two animals were examined and removed to the laboratory. They yielded 7 fleas. These fleas were dissected and the stomach contents stained and examined. In two of them plague-like bacilli were abundantly present. The guinea-pigs both died of typical plague. All the fleas caught in this house were rat fleas.

No. 17. 554 *Lady Jamsetjee Road*. This tenement consists of two small rooms, one opening off the other, on the top floor of a two-storied chawl. It was occupied by one of the clerks of the laboratory and his family. On 22. ii. 06 he brought with him to the laboratory a dead rat which he had found that morning in his house. This rat on examination was found to be plague infected. The occupants evacuated the house that day, and two guinea-pigs were put in and allowed to run free.

On the house being opened on 24. ii. 06 two more dead rats, which proved to be plague infected, were found. The guinea-pigs were examined, removed to the laboratory and segregated. They yielded 28 fleas, which were fed on a fresh guinea-pig in a flea-proof cage. This latter animal, as well as the other two guinea-pigs, died of plague within a few days.

No. 29. 51 *Umerkhadi Road*. This tenement consists of a tea shop with a small eating-room at the back. It is situated on the ground floor of a large building.

On 10. iii. 06 a dead rat was found in the back room. It was at once thrown out into the street. A few days afterwards an occupant of this room became infected with plague and about the same time a second case, in which the infection could be traced to this place, also occurred.

On 15. iii. 06 two guinea-pigs were put into the room and allowed to run free. Next day they were examined for fleas, removed to the laboratory and segregated. The fleas, 62 in number, were transferred

to a fresh guinea-pig in a flea-proof cage. All these three animals had died of plague by 20. iii. 06.

Summary.

Guinea-pigs allowed to run free in plague houses acted as good traps for fleas, on an average 20 per room being obtained. These fleas were mostly rat fleas. In 29 per cent. of these plague rooms the guinea-pigs left in for from 18 to 40 hours contracted plague. The situation of the bubo in these animals was, in the great majority of cases, in the cervical region.

SERIES II.

Experiments with guinea-pigs running free in plague houses which had been previously disinfected.

This series of experiments was of the same type as the first series, the only difference being that the houses had been disinfected before the guinea-pigs were put in.

The disinfection process was in every instance done by the Health Department of the Municipality of Bombay. In most cases it consisted in thoroughly washing the walls and floors with an acid solution of perchloride of mercury of a strength of 1 in 750, a solution which, as has been abundantly proved, readily kills the *B. pestis* even in organic mixtures. In a few instances gaseous disinfection with the fumes of burning sulphur was done, while in still a few other cases a combination of these two methods was carried out. In Table II (after p. 482) it is indicated which method was adopted in each individual instance.

Considering the evidence which has already been brought forward, together with that contained in the present paper, it will be clear that before the measure of success to be attributed to any process of disinfection can be gauged, it is necessary to ascertain what effect such disinfection may have had upon the fleas in the room and their infectivity.

Observations have therefore been made upon—

- (1) the number of fleas caught on guinea-pigs which were allowed to run free in the house after disinfection ;
- (2) the fate of these guinea-pigs—whether they died of plague or not.

Looking, first, at the result of the flea-hunt in these houses, we find that in many instances the number trapped by the guinea-pigs was very large, as many as 263 being taken in one instance, while the average of 31 observations was 40 per house.

Turning now to the number of the houses in which the guinea-pigs became infected with plague, we find that out of 31 observations one or more of the animals died of typical plague in nine instances, that is to say, that 29 per cent. of the houses were infective, the same percentage as in the non-disinfected houses. Of 13 cases in which more than 20 fleas were caught, 38 per cent. gave positive results. The situation of the buboes in the animals which died of plague was chiefly in the cervical region. Thus, in twelve animals the bubo was single in ten cases, and in these ten, eight buboes were in the neck and two in the groin. In the case of the two multiple buboes both were in the neck and groin.

These last observations tend to support our contention that in a plague-infected house the infection is not in the floor but in the fleas which are present in the house. For it has been abundantly proved that disinfection with acid perchloride of mercury carried out in the efficient manner described above is able to kill all plague germs present in the walls and floors, even when the latter are made of cow-dung. Now, we have shown that the flea inhabitants of the houses are not affected by the disinfection process and that at the same time a considerable percentage of the houses are able to infect guinea-pigs.

It is necessary to point out, that in one or two of the observations in which fleas were caught and the guinea-pigs contracted plague, these results were probably due to reinfection of the room by plague-infected rats, which it was impossible to exclude. Thus, in the case of experiment No. 10 dead rats were found on 29. iii. 06, 30. iii. 06, 1. iv. 06 and 4. iv. 06, while the disinfection was carried out only on 30. iii. 06 and 1. iv. 06. There was, therefore, an opportunity on 4. iv. 06 for the rooms to become reinfected before the guinea-pigs were put in on 11. iv. 06. Also, in the case of experiment No. 16 dead rats were found in the room on 10. iv., 12. iv., 14. iv., and 16. iv. 06: the room was disinfected on 14. iv. 06 after the rats found on that day had been removed: the guinea-pigs were put in on 15. iv. 06 and removed on 16. iv. 06, but not until after three more dead rats had been discovered in the room on that day. In the other cases, in which the room was shown to be infective, there was no evidence of reinfection,

but, except in a few instances, it was impossible to exclude this having occurred.

Summary.

Plague houses, which have been disinfected by the ordinary means, still contained fleas in large numbers, an average of 40 fleas per house having been taken in 31 observations. Further, 29 per cent. of these disinfected houses were infective for guinea-pigs allowed to run free in them. The situation of the bubo in these animals was in the great majority of cases in the cervical region.

GROUP II.

In this group of observations, which also is made up of two series, fleas obtained in plague houses were fed on rats or guinea-pigs in flea-proof cages in the laboratory. The two series only differ from one another in the manner in which the fleas were obtained.

SERIES III.

Experiments with fleas caught on plague-infected rats found in houses.

In Part II of the present paper it was shown that fleas fed upon artificially infected rats in the laboratory when subsequently transferred to healthy rats frequently conveyed the disease.

In this small series of observations, only three in number, fleas, which were caught on rats which were found dead or dying in houses in Bombay and subsequently proved to be plague infected, were removed from these rats and transferred to healthy animals in flea-proof cages in the laboratory (Table III, following p. 482.)

In the first experiment a rat was found in a dying condition in a house in Barrack Lane. It was noticed by the District Registrar to be covered with fleas. It was at once placed in a tin with a closely fitting lid and sent to the laboratory. On the tin being opened the rat was found to be dead and about 80 fleas were recovered from its body and from the tin itself. Half of these fleas were put on a white rat and the other half on a guinea-pig, each animal being placed separately in a flea-proof cage. The guinea-pig died on the 4th day and the rat on the

11th day, both of typical plague. The original rat showed typical post-mortem signs of plague, the blood containing numerous bacilli.

In the second experiment, three dead rats were found by us in a chawl at 280 De Lisle Road. On examination all of these rats proved to be plague infected. About 300 fleas were recovered from them and transferred to a guinea-pig in a flea-proof cage. This guinea-pig died of typical plague on the 4th day.

In the third experiment, a dead rat, which was afterwards proved to be plague infected, was found in a house in the village of Sion. Twenty-five fleas were caught on it and brought to the laboratory. They were then put on a guinea-pig in a flea-proof cage. This animal died of typical plague on the 4th day.

It is again interesting to record the position of the buboes in these three guinea-pigs, the infection to which was definitely known to have been conveyed by fleas. In every instance the bubo was in the cervical region.

Summary.

On three occasions, namely, every occasion on which the experiment was made, fleas transferred from plague-infected rats found in houses in Bombay were able to transmit the disease to healthy animals in flea-proof cages in the laboratory. Three guinea-pigs thus infected had the bubo in every instance in the cervical region.

SERIES IV.

Experiments with fleas caught on guinea-pigs and other animals which had been left for some hours in plague houses.

In this series of experiments fleas were caught on animals, in the great majority of cases on guinea-pigs, which had been placed in plague houses for from 18 to 48 hours, the houses being selected in the manner we have mentioned above.

The fleas were brought to the laboratory in test-tubes. They were then immediately put on fresh animals, mostly guinea-pigs, in flea-proof cages. The details of these observations are set forth in Table IV (after p. 482), which shows that in eight out of forty experiments the animals to which the fleas were transferred died of plague.

Of the eight animals which died, six were guinea-pigs. The distribution of the buboes in these guinea-pigs was as follows: three in

the cervical region alone, one in the inguinal region alone, one in the cervical and inguinal regions and one in the cervical and axillary regions.

Summary.

In a certain number of plague houses fleas can be trapped on guinea-pigs, which fleas are capable of giving plague to fresh animals in the laboratory. The situation of the bubo in these animals was in the great majority of cases in the cervical region.

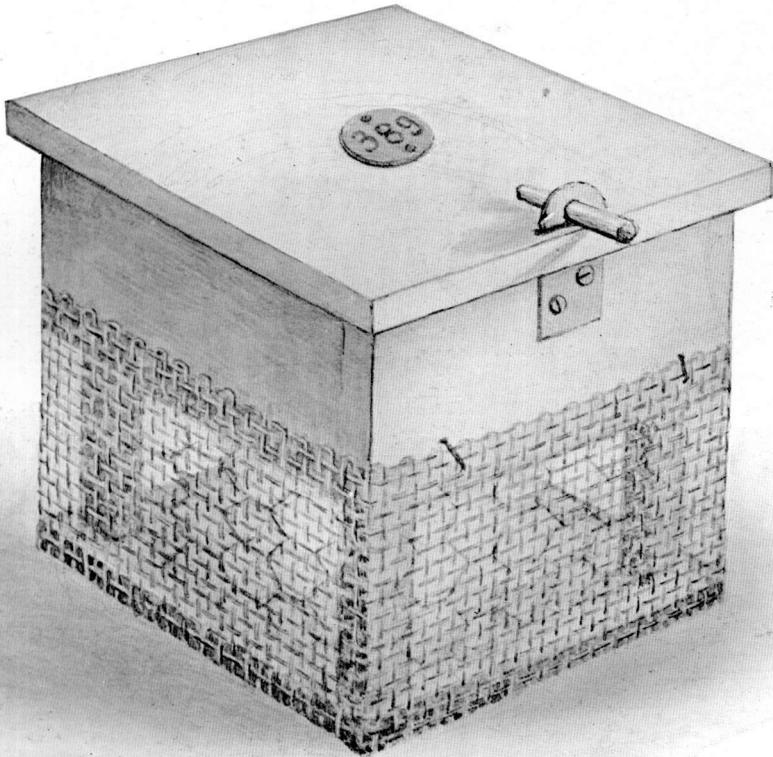
GROUP III.

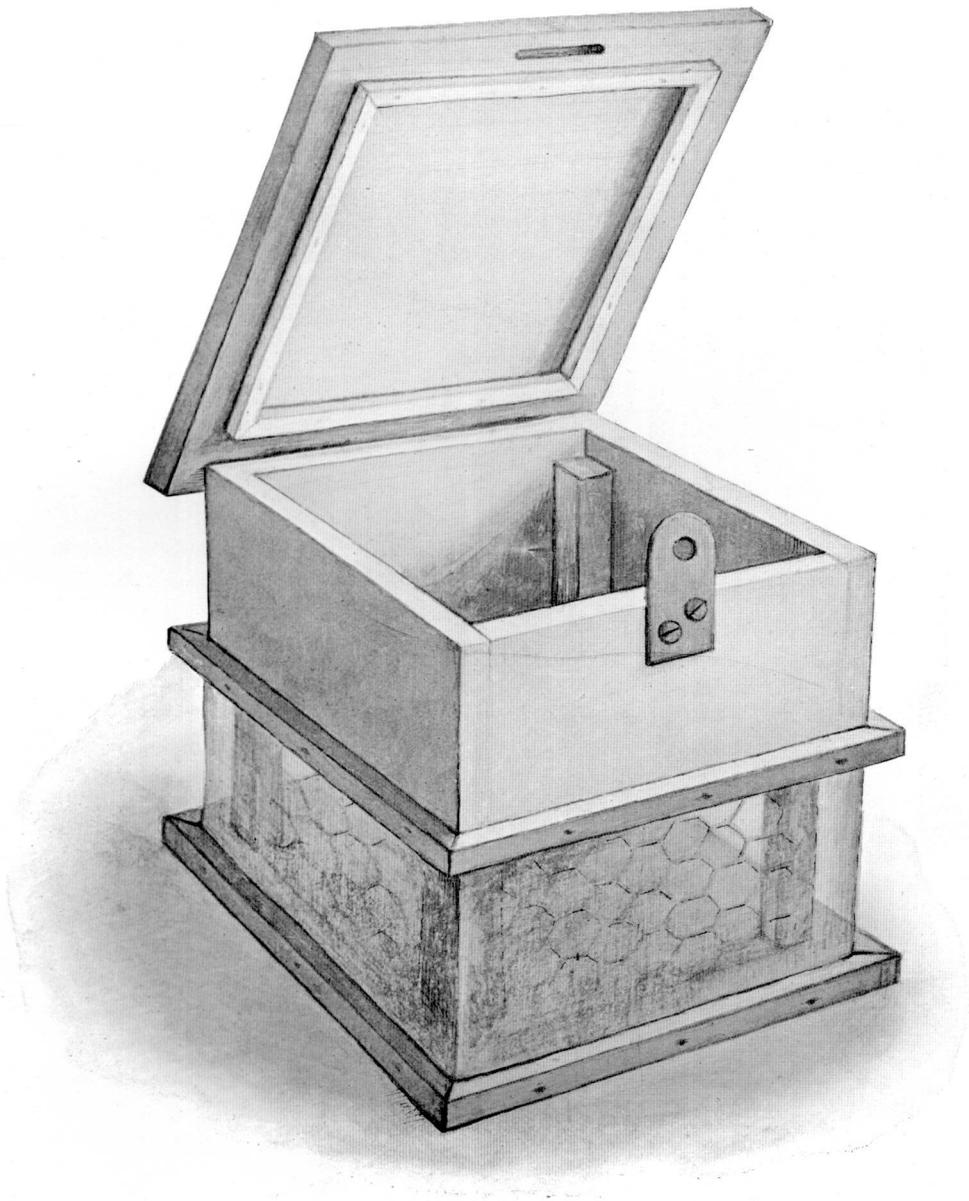
In this group of observations, which is also divided into two series, it was our aim so to contrive the conditions of experiment, that while all the animals were protected both from floor infection and from infection by contact with any plague-infected rats which might be in the room and were equally subject to aerial infection, half of them were protected from fleas and the other half were not so protected. For each experiment a pair of animals, one protected and the other not protected, was used.

SERIES V.

Experiments with animals in cages, unprotected and protected with fine wire gauze, placed in plague houses.

In this series the method of protection from fleas was by means of a curtain made of metallic gauze, the mesh of which was slightly larger than of that used for filtering petrol. The cages were of the following construction (see Plate VI). The upper portion, made of teak wood, was provided with a lid, which fitted closely, the junction being made completely flea-proof by means of a tongue and grooved joint. The floor, also of teak wood, was attached at each corner to the upper portion by means of a wooden pillar. The space thus left between the floor and the upper portion of the cage was closed in all round, in the case of the protected cage by two curtains, one of metallic gauze on the outside and the other of ordinary wire netting on the inside. This inner layer of wire netting prevented the animal itself damaging the gauze curtain, while the gauze curtain effectually prevented the access of fleas. It is also apparent that no contact between the animal inside the cage and animals outside was possible.





In the case of the "unprotected" cage (Plate VII) wire netting was substituted in place of the gauze, so that in this cage there was a double curtain of wire netting and a space of about $\frac{1}{2}$ -inch between the layers. While these layers prevented any possible contact between the animal inside the cage and any animals which might be wandering about the house, they did not prevent fleas from gaining access to the encaged animal. Two sizes of cages were employed, one size to hold monkeys and a smaller size for guinea-pigs and white rats.

In each experiment two animals, one protected and one unprotected, were placed side by side in a plague room, chosen as we have indicated above. They were left in the room for about 48 hours and then brought back to the laboratory. The animals were now chloroformed and searched for fleas, all of which were removed. They were then placed in ordinary cages and segregated, the fleas being in some instances transferred to fresh animals in flea-proof cages.

Working in this manner we have completed 42 experiments, the details of which are tabulated in Table V (follows p. 482).

First, from this table it is seen that on 24 occasions fleas were caught on the unprotected animal but never on the protected one. In this connection it is, however, to be noted that the fleas were, as might be expected, never so plentiful, averaging only three per house, on these caged animals as on the guinea-pigs which were allowed to run free in the experiments of Group I.

Secondly, it is seen that not one of the protected animals contracted plague, while four (10 per cent.) of the unprotected animals, guinea-pigs in every instance, died of this disease. The small number of successes in this series of experiments in comparison with those in which the guinea-pigs were allowed to run free is probably to be explained by the fact, mentioned above, that fleas did not reach the caged animals in anything like the same number as the free animals. Thus, we have seen that on an average in Series I of Group I 20 fleas, and in Series II 40 fleas, per house were obtained from the guinea-pigs, while in this last series on an average only three fleas per house were taken.

Finally, it is again interesting to record that in these four guinea-pigs in every instance the bubo was in the cervical region alone.

Summary.

Forty-two experiments were done, in which two animals, one protected from fleas by means of a wire gauze curtain, the other not

so protected, were placed side by side in a plague house. Both animals were protected both from soil infection and from infection by contact with animals outside, but were equally subject to aerial infection. While not one of the protected animals contracted plague, four of the unprotected ones died of this disease. The number of fleas caught on the unprotected animals was very many times less than the number taken on the guinea-pigs running free in the experiments of the first group. No fleas were caught on the protected animals. The position of the bubo in the guinea-pigs which developed plague was in every case in the cervical region.

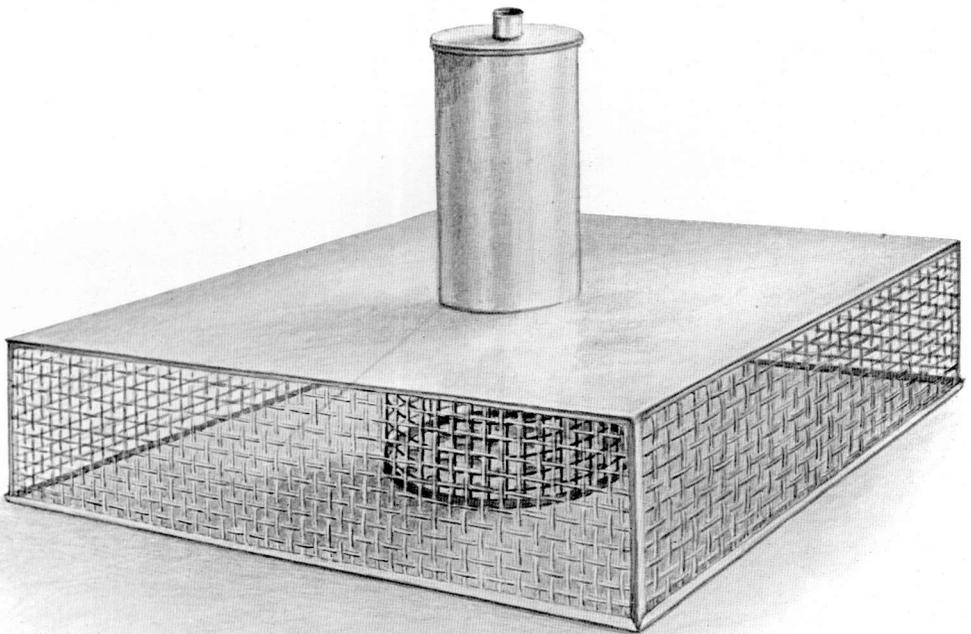
SERIES VI.

Experiments with animals in cages, one surrounded with "tangle-foot," the other not so protected, placed in plague houses.

The experiments of this series differ from those of the last series in that one of the animals, instead of being protected from fleas by means of a metallic gauze curtain, was surrounded by an area spread with "tangle-foot"¹, which in the case of the other animal was replaced by a layer of sand. By this contrivance it was expected that fleas, which were attempting to get at the animals, in the case of the tangle-foot cage would be caught on this material, but that in the case of the sand cage with no such barrier to cross they would be able to get at the animal itself. At the same time both animals were protected from soil and contact infection and were equally exposed to aerial infection.

For the purpose of these observations the following apparatus was devised (see Plate VIII). A central cage, made of wire netting with a mesh of $\frac{1}{8}$ -inch, held the animal. This cage was fitted with a bottom of perforated tin to allow urine to drain out. It was prolonged upwards by means of a funnel made of tin, the upper opening of this funnel being furnished with a closely fitting lid. This top opening gave access to the cage both for the purpose of placing the animal therein and for the purpose of feeding it. The cage stood in the centre of a square sheet of tin, which, in order to receive it, was provided with a depression. The minimum measurement from the side of the cage to the margin of this tin sheet was six inches. Lastly, in order to protect the animals from outside contact and in order to prevent the tangle-foot from being destroyed, there was provided an

¹ Tangle-foot is a sticky resinous preparation used for catching flies.



outer curtain of large mesh wire netting which was carried on a tin sheet of the same size as the bottom sheet. The funnel of the cage projected through an opening in the centre of the upper tin sheet, this joint being made flea-proof by means of solder.

It will be apparent, therefore, that the upper tin sheet with the cage in its centre and the wire curtain hanging down from its margins formed one portion of the apparatus, which portion could at any time be separated from the bottom sheet. In the case of the cage provided with tangle-foot, this material, which consists of sheets of thick paper coated on one side with a patent sticky resinous substance, was pasted on the upper surface of the lower tin sheet all round the depression in which the cage stood. There was thus a layer of tangle-foot, the minimum width of which was six inches, between the animal and where the edge of the apparatus met the ground, which layer a flea had to cross before it could get to the animal. In the case of the other cage, instead of the tangle-foot a thin layer of sand was spread.

The above description applies to the cages which were used for white rats and guinea-pigs. The cages which were employed for monkeys were of exactly the same design but were larger and were made in teak wood instead of tin-plate.

Into each room to be tested two animals were put side by side, one in a tangle-foot cage, the other in a sand cage. At the end of about 48 hours they were examined.

First, all the fleas which were stuck on the tangle-foot were removed and placed in alcohol. They were examined under the microscope and identified, a note being made as to whether they were human, cat or rat fleas. They were then dissected, the stomach contents being removed, spread on a slide, stained and examined for the presence of plague-like bacilli.

Secondly, the animals themselves were chloroformed, and searched for fleas, which were removed. They were then placed in ordinary cages and segregated.

In Table VI (following p. 482) are set forth the results of these observations.

The first points which come to view are the species of the fleas caught on the tangle-foot and the number of these which were infected, that is to say, contained plague-like bacilli in the stomach. From the table it is seen that out of 247 fleas identified, 147 were human, 84 rat and 16 cat fleas. It is also seen that in nine experiments

the fleas caught on the tangle-foot contained in their stomachs bacilli microscopically identical with the plague bacillus. Further, it is seen that out of 85 human fleas dissected only one was infected, while out of 77 rat fleas examined 23 contained plague-like bacilli. Only four cat fleas were dissected and none of these was infected.

The second point of interest is to be found in the number of fleas taken on the animals themselves. A reference to the table will show that only on three occasions were any fleas caught on the animals surrounded by tangle-foot, namely, in No. 8, one flea was obtained, but the rat had not been examined for fleas before it was put into the cage: in No. 26, one flea was taken, and in No. 27 two fleas were obtained. In these observations, however, the tangle-foot, for sake of experiment, was made only $2\frac{1}{2}$ inches minimum width, a distance, which it was afterwards ascertained, a rat flea could easily jump. On the animals in the cages surrounded by sand, fleas were got on thirteen instances, on one animal as many as 20 fleas being caught.

The third and the last point which calls for our notice is the fate of the animals. While not one of the animals which were surrounded by tangle-foot developed plague, six of those left unprotected contracted and died of the disease, five of these being white rats and one a monkey. We can also regard experiment No. 7 as yielding a successful result. For while the rat, which had been in the sand cage, was being chloroformed preparatory to being searched for fleas, it died: the fleas, 20 in number, which were taken on it, were at once transferred to a fresh rat in a flea-proof cage. This latter rat died of typical plague. Thus, out of 29 experiments with these cages, seven, or 24 per cent., gave the same result, namely, that while the animal surrounded by tangle-foot survived, the control animal left unprotected contracted plague.

Most of the positive results were obtained in two houses, namely, in a chawl situated at 280 De Lisle Road and in a house, No. I 47, 67 in Agarwada, Sion. While we reserve a detailed description of the course of events in these houses to a later date, we think it would not be out of place at present to draw special attention to the observations which were made in these two houses and which are recorded in Tables V and VI. As regards the house No. 280 De Lisle Road, in every room in which cages were placed dead rats had been found and these rats, with one exception (No. 6), had been proved to be plague infected at the laboratory. Plague cases had also occurred in several of the rooms, but it is to be noted that the

inhabitants completely evacuated the chawl soon after the rats began to die. Eight rooms were experimented with, one pair of animals being put into each room. In every instance tangle-foot was used as the agent of protection from fleas. Fleas infected with plague-like bacilli were found stuck on the tangle-foot of every cage, and not one of these eight protected animals died of plague. Of the eight animals which were surrounded with sand in place of tangle-foot, two died of typical plague, and the fleas caught on a third, which died under chloroform, gave plague to a fresh animal to which they were transferred.

As regards the house in Sion Agarwada, several dead rats, which were proved at the laboratory to be plague infected, had been found. All the inhabitants evacuated the house on the first dead rat being discovered. We put into this house five pairs of animals, two animals protected with metallic gauze and their controls and three animals protected with tangle-foot and their controls. The result was that while not one of the protected animals contracted plague, three out of the five unprotected ones, one of them being a monkey, developed the disease and died.

Summary.

Animals protected from fleas by means of a sufficiently broad layer of "tangle-foot" and placed in plague-infected houses do not contract plague, but the control animals, not so protected, on several occasions (24 per cent.) developed the disease. Out of 247 fleas caught on the "tangle-foot," 60 p.c. were human, 34 p.c. were rat and 6 p.c. were cat fleas. Plague-like bacilli were demonstrated in the stomach contents of one out of 85 human fleas dissected, and of 23 out of 77 rat fleas.

General Summary and Conclusions.

(1) Guinea-pigs allowed to run free in plague houses in many instances attracted a large number of fleas, which fleas were mostly rat fleas. A certain percentage (29) of these animals contracted plague and died from the disease. The position of the bubo in the great majority of these cases was cervical.

(2) If a plague house had been previously disinfected by the ordinary means of disinfection, fleas were still caught in large numbers on guinea-pigs set free in them. Further, a considerable number (29 per cent.) of these animals died of plague. The bubo in the great majority of these cases was again in the cervical region.

(3) Fleas transferred from plague-infected rats found dead or dying in houses were able to transmit plague to healthy animals in flea-proof cages in the laboratory. The bubo in all cases was in the cervical region.

(4) Fleas transferred from guinea-pigs and other animals which had been placed for a few hours in plague houses were able to transmit the disease to fresh animals when fed on these in flea-proof cages in the laboratory. The situation of the bubo in these animals was in the great majority of cases in the cervical region.

(5) Animals were placed in plague houses in pairs, both protected from soil and contact infection and both equally exposed to aerial infection, but one protected from fleas by means of a fine metallic curtain and the other not so protected. None of the protected animals contracted plague while several of the unprotected animals died of the disease. The position of the bubo in every instance was in the cervical region.

(6) Animals were placed in plague houses in pairs, both protected from soil and contact infection and both equally exposed to aerial infection, but one surrounded with a layer of "tangle-foot" and the other surrounded with a layer of sand. The following observations were made:—

(a) Many fleas were caught on the tangle-foot, a certain proportion of which were found on dissection to contain in their stomachs abundant bacilli microscopically identical with plague bacilli. Out of 85 human fleas dissected only one contained these bacilli, while out of 77 rat fleas 23 were found thus infected.

(b) The animals surrounded with tangle-foot in no instance developed plague, while several (24 per cent.) of the non-protected animals died of the disease.