

## XX. A NOTE ON MAN AS A HOST OF THE INDIAN RAT FLEA (*P. CHEOPIS*).

Experiments already published (vol. VI. p. 435), and since repeated with similar results, afford ample confirmation of the observations of Simond (1898) and of Gauthier and Raybaud (1902, 1903) that plague may be transmitted from rat to rat by the agency of rat fleas. The direct experiment to show that plague can be conveyed in the same way from rat to man can never be made, and the inferential transference of the results of the experiments on rats to the spread of human plague has been not a little opposed, notably by Galli-Valerio (1900, 1903), on the ground that rat fleas do not bite men. This may be true of the fleas (*C. fuscatus* and *T. musculi*) commonly found on rats in Western Europe, but Gauthier and Raybaud (1902, 1903) in Marseilles, and Tidswell (1903) in Sydney, obtained direct evidence to the contrary with regard to *P. pallidus* (= *P. cheopis*), and Liston (1905) found that *P. cheopis* in Bombay readily attacks man during the plague season.

We have made many observations which show that *P. cheopis* will make use of man as a host, and may be captured in large numbers on men in houses infested with rat fleas.

### I. *Observations made in the laboratory.*

During the last year or more we have had occasion to make a large number of experiments on the transmission of plague from animal to animal by means of the rat flea. We have also carried out many experiments on the breeding of these fleas at different seasons of the year. During the course of these observations we have often noticed that, if a man's hand is put into a cage containing rat fleas, the fleas will jump on to the hand, and, if given time, will feed on it. This they will do the more readily, if they have been left without their natural food, a rat, for 24 hours or longer. We

have also made the observation that, if the fleas in the cage are abundant and the natural food supply limited, a few fleas will feed on a man's hand even in the presence of a rat. Having, therefore, demonstrated that rat fleas would feed on man, we next proceeded to ascertain if they could be kept alive on this diet for any length of time. The following was the method employed:—about 40 fleas, caught on healthy Bombay rats, were placed in a wide-mouthed jar, which had a little sand at the bottom. Twice daily a man's hand and forearm were introduced into the jar and left in for 15 minutes each time. Fleas which crawled up the forearm were gently pushed back before they could escape. It was observed that the fleas bit readily and the man himself was soon cognisant of the fact. About every ten days the sand was removed and fresh sand substituted, so that multiplication of the original fleas by breeding was excluded. Five experiments in all were made in this way, with the following result.

*Experiment 1.* One flea was found alive on the 24th day.

*Experiment 2.* One flea was found alive on the 9th day. In this experiment the sand had not been washed, and there was present a fine dust, which by blocking the tracheal openings was probably prejudicial to the lives of the fleas. They were often observed to be dusted over with this material.

*Experiment 3.* One flea was found alive on the 25th day.

*Experiment 4.* One flea was found alive on the 25th day.

*Experiment 5.* One flea was found alive on the 27th day.

From the above experiments it is seen that we were able to keep rat fleas alive for nearly four weeks by feeding them on human blood. There was a considerable mortality during this time, but the main facts stand out, (*a*) that they fed readily on man, and (*b*) that some of them were still alive after 25 days.

Rat fleas kept under similar circumstances, but without food, never survived longer than one week.

## II. *Observations in the course of the godown experiments.*

We have previously (vol. VI. p. 450) detailed a number of experiments made in godowns or cabins, some of which were infested with rat fleas. The present observations were made mostly during some recent experiments similar to those already described.

In the course of these experiments men had to enter the godowns

for the purpose of removing dead animals and for the purpose of feeding those which remained alive. We have on many occasions caught fleas on the legs<sup>1</sup> of these men, especially if, as happened in some instances, the godown had been empty for some days. It was also noted that if guinea-pigs were present it was still possible to obtain a few fleas on the legs of those entering the godowns. Several observations have been made, in which the fleas which were caught after the man had been in the godown for a given time were enumerated. Three of these observations will serve as examples:—

1. Godown 1 contained abundant rat fleas. On 3. XII. 06 a man entered the godown to remove some cages containing monkeys which had been kept inside for two days. He entered the godown four times, and 44 fleas in all were caught on his legs; 25 the first time he came out, 10 the second time, 3 the third time, and 6 the fourth time. Each time he waited in the godown no longer than was required to pick up and remove the cage.

2. Godown 1 contained abundant rat fleas. On 19. I. 07 a man entered the godown four times to remove some cages containing monkeys, which cages had been inside for two days. The first time he entered he was in the godown for half a minute, and on his coming out 19 fleas were taken on him; the second time he was inside for quarter of a minute and 5 fleas were taken on him; the third time he was again inside for quarter of a minute and 5 fleas were taken on him; the fourth time he was inside for 20 seconds and 1 flea was taken on him. Altogether he was in the godown for about 1½ minutes and 30 fleas in all were taken from his legs.

3. An exactly similar observation to the above was made on 25. I. 07, when 15 fleas were taken on the man<sup>2</sup>.

### III. *Observations made in houses in Bombay.*

During the epidemic of 1906 we had occasion to make numerous observations, as has been already described (vol. VI. p. 467), in houses in Bombay which were presumably plague infected. In the course of these observations our assistants and ourselves had to enter the houses for the purpose of placing animals therein. We have on many occasions

<sup>1</sup> It is to be noted that the men had always their legs bare.

<sup>2</sup> It may be noted in passing that as these godowns were infected with plague the men, whose duty it was to enter them, had been previously well immunised with Haffkine's prophylactic. None of them contracted the disease.

caught rat fleas on our own persons, as well as on those of the attendants. We have in some instances made definite enumerations of the fleas caught and have at the same time noted the species carefully.

280, *De Lisle Road*. We have recorded already (vol. VI. p. 480) several experiments carried out in this building, in which animals protected from fleas escaped infection, while those which were unprotected developed plague. The building was a long corrugated iron shed with earthen floor and divided into small rooms by partitions. Many plague-infected rats were found, while in some of the rooms plague cases had occurred. The building was, in short, unusually severely stricken with plague, and had been evacuated when the present observations were made.

(1) *April 17th*. 40 fleas were caught on a man who went into one of the rooms for a short time. They were all *P. irritans*.

(2) *April 18th*. 113 fleas were caught on a man who entered one of the rooms. The species were as follows:—*P. irritans* 55, *P. cheopis* 51, *P. felis* 7.

(3) *April 19th*. 76 fleas were caught on a man who entered one of the rooms for a short time. The species were as follows:—*P. irritans* 40, *P. cheopis* 34, *P. felis* 2.

(4) *April 20th*. 80 fleas were caught on a man who entered one of the rooms. The species were as follows:—*P. irritans* 18, *P. cheopis* 60, *P. felis* 2.

Thus, in three out of four rooms of this chawl, which was badly infected, abundant rat fleas were taken on the legs of men who entered the rooms only for a short time.

#### *Summary and Conclusions.*

We have shown that in the laboratory the rat flea, *P. cheopis*, will readily bite man. When very numerous it will bite man even in the presence of its natural host. We have been able to keep this species of flea alive for more than three weeks by feeding it on man alone.

In the course of some experiments in godowns which were infested with *P. cheopis* alone, we have often taken fleas in considerable numbers on the legs of men who have entered the godowns for a short time.

In a building in Bombay, in which there had been a severe rat mortality, proved to be due to plague, we have taken rat fleas in large

numbers on the legs of men who entered some of the rooms in this building even for a short time.

We can conclude, therefore, that the rat flea, *P. cheopis*, under certain circumstances, is attracted by man, and will readily bite and feed on him.

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