are also necessary to forecast probable happenings in the near future. They may also possibly throw some light on the epidemiological factors concerned with the periodicity of the disease. Such investigations have been projected.

In conclusion, a warning may be given. Fifty-two years ago definite diagnosis of the first case of plague in Calcutta was made by Dr. Simpson, the health officer. It was not taken seriously. Epidemic followed. Plague had come stealthily to Calcutta in 1895, as it has come to us now, with a low fatality rate. In fact the non-venereal buboes which had occurred amongst the Shropshire Regiment stationed in Calcutta in 1895 were not accepted by the army authorities as plague and the disease was ignored or suppressed for three years during which period its evolution was slowly proceeding. What was the result? Beginning from 1898 the annual mortality from plague had risen from 26.5 per 100,000 to 883 per 100,000 in 1900. Plague ravaged the city severely for the next 10 or more years and disappeared only after 1925. What the Editor of the *Indian Medical Gazette* wrote in 1897 is of equal applicability to-day and may be quoted below :—

'We had no desire of referring to Shropshire Regiment, but as the Medical Board has published the fact that cases of non-venereal buboes have occurred among the soldiers of that regiment, we cannot help remembering the fact that they came from Hong Kong in the beginning of 1895, that they were active in stamping out the plague, that fatal cases occurred among them, that they have suffered from non-venereal buboes ever since, and it is only since the coming of the Shropshire Regiment that difficulties in diagnosis regarding the buboes appear to have arisen. . . . The attitude of the Medical Board is easily understood and from many points of view especially the commercial appears to be laudable; but when viewed from a wider aspect, it is a short-sighted policy, and not likely to be in the best interests either of the public or even the mercantile community. We have an example in Bombay of similar policy as that pursued by the Medical Board and its results. Bombay concealed its first cases, then minimized them and now it is face to face with a severe epidemic, its trade is ruined, and by its flying population it is likely to spread the disease far and wide'.

A NOTE ON THE INVESTIGATION OF SUSPECTED PLAGUE CASES IN THE CAMPBELL HOSPITAL, CALCUTTA

By G. PANJA, M.B., D.Bact.
Professor of Pathology and Bacteriology
and
S. K. GUPTA, M.B.
(From the School of Tropical Medicine, Calcutta)

WE started investigation on 16th April, 1948.

Material was collected from 77 cases, although we took notes of 119 cases. Some were not evidently plague cases.

In the first few days of our investigation, we isolated *Past. pestis* from 8 clinically typical cases. The organism was identified in every positive case by morphological and staining reactions, biochemical reactions, agglutination with mono-specific anti-plague serum and finally by animal inoculation tests. Agglutination test on a slide proved highly useful in identifying the organism. Later we found that biochemical and animal inoculation tests were not necessary for identification. A gram-negative thick, short rod-shaped organism growing in characteristically sticky colonies and showing high agglutinability with antiplague serum were sufficient for identification.

Bacteriological examination for *Past. pestis* proved negative in the remaining 69 cases. *Streptococ. pyogenes* was isolated in 2 cases, *Staphylococ. aureus* in 5 cases and *Streptococ. viridans* in 1 case—all isolated in pure culture.

Most of the cases in which plague bacilli were not found were clinically suspicious cases of plague. The negative findings might have been due to either of two causes : (*i*) the cases were of mild type; (*ii*) most of them were having sulpha treatment before the material was taken. It is interesting to note here that in one case *Past. pestis* was isolated even after 2 days' treatment with streptomycin.

All the cases were of bubonic type. In one case only was *Past. pestis* isolated from the circulating blood. In 3 of our cases, which proved fatal, no septicæmia was found, suggesting thereby that death was due rather to endotoxæmia than bacteræmia.

All bacteriologically positive cases came from one locality of the town, namely Lower Chitpur Road, Chunagalli, Rotu Sarkar Lane, Harinbari Lane, Canning Street, Jeliatola Street, etc. From no house more than one case came for admission.

It is also interesting to note that all bacteriologically positive cases that survived showed presence of diagnostic agglutinin (from 1 in 20 to 1 in 320) in their blood from the 7th to the 10th day after illness. In the majority of the bacteriologically negative cases, no agglutinin was found. In 3 suspected cases only, although bacteriologically negative, diagnostic agglutinin was found against 4 strains of *Past. pestis* tested. This is highly important as a diagnostic procedure, since puncture of a small deep-seated bubo is difficult and bacteriological finding is often negative. Moreover, most cases get sulphadiazine treatment before puncture is made and therefore the chance of getting a positive result becomes remote.

We found the recently isolated strains of *Past. pestis* most suitable for agglutination test. No auto-agglutinability was noticed. Both the slide method and Dreyer's method were adopted but the slide method was more convenient, time-saving, and gave clear-cut results. It must be mentioned here that the result of slide agglutination should be noted only a minute after intimate mixing of the bacilli with the diluted

serum. Twenty-four hours old nutrient agar culture subcultured from day to day acted as a good agglutinogen. A prepared saline suspension was found less suitable for slide agglutination.

We have kept an open mind in the bacteriologically negative cases showing no agglutinin for *Past. pestis*. We have injected materials into animals in the hope of finding some virus but so far nothing definite has been obtained. We also carried out Paul-Bunnell's test on a large number of sera but no clumping of sheep red cells in diagnostic titre was found. In conclusion, we like to lay stress on the point that for diagnosis an agglutination test must be carried out on all cases from the 5th to 10th day of their illness if bacteriological finding is negative.

A NOTE ON FLEAS AND RATS WITH REFERENCE TO PLAGUE IN CALCUTTA

By D. N. ROY, M.D., D.T.M.

Professor of Medical Entomology, School of Tropical Medicine, Calcutta

THE rat flea is the intermediate host of the parasites of bubonic plague. Fleas are regarded as free parasites as they remain on the host generally during the time they feed. The flea passes through the egg, larval, pupal and adult stages and the whole life cycle covers roughly three weeks. The eggs are deposited in places where the host rests. For egg-laying, the female usually selects dark and dry places such as rubbish, debris and dust in domestic houses, under the carpet, in godowns and granaries, etc. Rat fleas often lay eggs in rat holes. Fleas of either sex live exclusively on blood which is absolutely necessary for their own nutrition and also for the nutrition of the ovum. If fleas are unable to obtain the blood of the proper animal on which they are usually found, they may attack other animals. Under normal circumstances the rat flea will always be able to find a rat to return to, but where the number of rodents has been appreciably decreased which happens during an epizootic of plague among rats, the flea is driven by hunger to attack man.

The average flea is able to jump about 3 inches from the ground when gorged, and about 4 inches when starved. It is also capable of walking up a vertical sheet of glass for about 8 inches after which it falls back to the ground. Horizontally it is unable to cross a ditch 6 inches wide but it can remain afloat on water for some hours.

The flea is unable to pierce the skin through ordinary cotton or woollen socks for feeding.

The duration of life not only of the adult flea but also of other active stages is influenced greatly by the two important factors, temperature and humidity. An increase of humidity and also of temperature has a tendency to retard the growth of all these stages.

The rodent flea, *Xenopsylla cheopis*, is the most concerned in the transmission of plague. This flea is widely distributed in the tropics and is the principal plague flea in the oriental regions and also in Africa. It is widely prevalent in the plains in India. *Xenopsylla astia*, another rodent flea, also takes part in the transmission of plague.

A large number of surveys carried out in India have demonstrated the distribution of *cheopis* in relation to plague in India, in a broad sense, to be fairly constant. Where *astia* is in excess of *cheopis*, (1) the places may be plague-free, (2) a small outbreak may occur or (3) in certain localities this flea may also play the same rôle as *cheopis*. Where *astia* is the vector, it does so by its number and in such cases the epidemics are small and are seldom carried over to the off season.

The flea index represents the population of fleas on a single rat. This is determined by catching rats and collecting the fleas after killing both the rat and the fleas with chloroform. It, however, makes no allowance for the floating population of fleas at large in rat nests. It is generally assumed that the unknown proportion of fleas which exist on the rat's body is approximately constant.

In recent years two surveys of Calcutta rat fleas have been carried out. The first was by Strickland and Roy in 1930 and the second by Rao in 1941. Strickland and Roy obtained a low flea index, whereas Rao obtained a much higher figure especially for *cheopis*.

The marked feature of the flea index observed by Rao was the wide variation from ward to ward and in the species of rodents from which the fleas were collected. Of the three species of rats present in Calcutta, *Rattus norvegicus* showed the highest flea index (9.0), while *Rattus rattus* and *Gunomys varius* showed a general flea index of 4.3 and 4.9 respectively. The house mice, *Mus musculus*, and *Crocidura coerulea*, the musk rat, showed a very low infestation rate.

The two most important species of domestic rats are *Rattus rattus* and *R. norvegicus*. The former is popularly known as the black rat and the latter, the brown rat.

R. rattus.—The tail is often about one and a quarter times as long as the head and body combined; the eyes are large and prominent; the ears are large; muzzle narrow; tail uniformly dark; feet slender, white but sometimes dark. The colour in the Indian species is usually brown and the belly yellowish white. It is widely distributed in India. In Calcutta the proportion of this species of rodent is decidedly lower than *R. norvegicus*. It is a rat which lives in the house and is a good climber. This rat is much more dangerous than *R. norvegicus* from the epidemiological point of view.

R. norvegicus.—The tail is about 90 per cent the length of head and body. It is a heavy-bodied rat with a large heavy tail which is generally white or distinctly light in the lower half; ears and eyes small; the feet are large,