PUBLIC HEALTH REPORTS

VOL. 45 NOVEMBER 21, 1930 NO. 47

AN UNUSUALLY MILD RECURRING EPIDEMIC SIMULATING FOOD INFECTION

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In various localities of the northwest mountainous section of the United States a mild dysentery-like epidemic has occurred from year to year. The infection has been strictly seasonal, practically all of the cases occurring during the hottest and driest months of the year, July and August. For the past few years it has been more noticeable in certain of the national parks where large numbers of tourists are assembled during the summer months, but the condition has never been limited to these areas. On the other hand, the condition herein described has not affected, so far as known, the large centers of population in the East.

In 1929 an unusually large number of cases occurred in Yellowstone Park, and affected both tourists and employees at every hotel and camp. First-hand information was not obtained during the summer of 1929, but the following chronological history of the epidemic as it occurred at the Lake Hotel was obtained from the hotel manager, who had kept a written record:

August 4, 1929: In the early morning six employees of the hotel (total number of employees, 155) complained of being sick during the preceding night. The symptoms were practically identical in each case. About 1 a. m. they were taken with nausea, vomiting, sharp pain in the abdomen, and diarrhea. After a few hours they went back to sleep with no further symptoms.

The manager learned on this date that four days earlier two national-park rangers of the Lake ranger station near by had complained of a similar affection.

In the early afternoon of the same day one maid at the hotel became sick, and at 5 p. m. two porters became ill, and from then on one employee after another was taken sick in rapid succession until about 80 had become ill with the same symptoms of nausea, vomiting, and diarrhea. Those taken ill in the afternoon felt much better by midnight, took some broth, and were able to work the next morning, although they were quite weak.

August 5, 1929: At 1 a. m. many guests became ill at about the same time. The hotel manager and two national-park nurses took care of about 20 guests with symptoms of nausea, vomiting, and diarrhea. These guests had requested medical assistance. There were at least 20 or 30 more who reported their illness about 8 a. m., but had not called anyone earlier. The same morning all guests, with one exception, were well enough to make their departure. This one patient had had "stomach trouble" since leaving Los Angeles. At 8 a. m. Dr. G A.

of the Pan American Sanitary Bureau, indicating the success of the antiplague campaign in eliminating plague from Guayaquil and greatly reducing the incidence of the disease in the remainder of the country.

The following article is an extract of Doctor Long's report to the Pan American Sanitary Bureau regarding the antiplague campaign in Guayaquil and vicinity.

ANTIPLAGUE CAMPAIGN IN GUAYAQUIL AND VICINITY

Extracts from a report by Dr. JOHN D. LONG, *Representative of the Pan American Sanitary Bureau*

In June, 1929, the directing council of the Pan American Sanitary Bureau authorized, by resolution, the undertaking of epidemiological studies of bubonic plague in South America, with the proviso that such studies should begin in Ecuador on account of the fact that preliminary studies had indicated that, probably, some interesting discoveries might be made in the epidemiology of the disease.

In accordance with the terms of the resolution above referred to, and with the consent of the national health service of Ecuador, Dr. John D. Long, accompanied by Surg. C. R. Eskey, of the United States Public Health Service, who had been appointed epidemiologist, arrived in Guayaquil on August 25, 1929. Preliminary arrangements were made and active work was begun on September 18, 1929.

Bubonic plague gained entrance into the city of Guayaquil in 1908. Since that time it has been carried to the towns along the Guayaquil & Quito Railroad, and to the towns along some of the rivers. It has also been present at times in some of the coast cities. The coast cities are, however, now free, and have not had plague for several years. From the infected towns along the line of the railroad the disease spread to the Indian villages (caserios) and has existed in them in semisporadic form for some years. The Province of Loja, in the southern part of the country, was probably infected from Peru, as communication with other sections of Ecuador is very difficult, while there is constant communication with the border towns of Peru, and the disease is present on both sides of the border. On account of the difficulties which attend the transportation of personnel and supplies to Loja, nothing has been done in that Province as yet. Arrangements have been made, however, to begin active work there at the same time that work is being done in Peru. Danger of the reinfection of the cleaned up parts of Ecuador from Loja is believed to be very remote, on account of the transportation difficulties mentioned and the separation of Loja from the remainder of the country by a lofty chain of mountains.

As Guayaquil, in the 22 years that plague has been present there, has had over 7,200 cases of the disease, and as the type of construction in common use favors the breeding and harboring of rats, it seemed to be the most important point of first attack. Efforts were therefore devoted to that city from the beginning of the campaign in September until December. In December a trip of study and inspection was made into the interior of the country along the line of the railroad and to some of the near-by Indian villages.

PLAN OF THE CAMPAIGN IN GUAYAQUIL

Trapping of rats.—Trapping was resorted to for the double purpose of destroying as many rats as possible and obtaining rats for laboratory examination in order to have constant information as to the percentage of plague infection among them and to know when the plague had disappeared. For the purpose of reducing the rat population to as low a figure as possible, it was decided to resort to the use of poison on a large scale. The method of using the poison and the results obtained will be described later.

In round numbers 43,000 rats (excluding mice) have been trapped, approximately 60 per cent of which were examined. In November of 1929, 1 rat to each 150 examined was infected with plague. At the present time about 6,500 rats have been examined without finding any infection among them. The last plague rat was found March 26, 1930. It was 1 in 3,500 examined. In the beginning, with 1,400 traps, about 12 rats per 100 traps per day were caught. Later, with approximately 6,000 traps in daily use, about 3 rats per 100 traps per day were being caught—an apparent reduction in the rat population of 75 per cent. In the beginning the flea index per rat was as high as 12. This has dropped to 3—also an apparent reduction of 75 per cent. Approximately the same number of *rattus* and *alexandrinus*, as of Norway rats, are being caught, actually a few more *rattus* and *alexandrinus*. Experience here as well as in other cities shows that when the catch of Norway rats is reduced to the same number as that of *rattus* and *alexandrinus*, both human and rodent plague disappear. This balance between the various species of rats was reached about the 1st of April, 1930. The last human and the last rat cases were discovered on March 26, 1930.

Trapping was also carried on in the village of Duran (Eloy Alfaro), across the Guayas River from Guayaquil, the terminus of the Guayaquil & Quito Railroad. Results were not very satisfactory and no infected rats were found. Trapping was soon abandoned there, and poison has been continuously employed since.

Some trapping was done in some of the interior towns, such as Milagro, Ambato, and Huigra. As the results were not very satisfactory and but few rats were caught, the practice was soon abandoned

and poisoning substituted. Human cases of plague soon disappeared. Some trapping still continues in Ambato for the purpose of sending slides and specimens to the Quito laboratory in order to determine whether rat plague still exists.

It was decided that trapping is a useful measure for the purpose of obtaining rats for laboratory examination to determine the plague index among them, but that as an antiplague measure in the extermination of rats, its value is not great.

Poisoning of rats.—From the beginning of the campaign poison was used on a large scale, not only in the city of Guayaquil but in a number of small towns and cities as well, with very good results.

At first the poison used was composed of corn-meal flour, to which 35 per cent of barium chloride had been added, together with a very small quantity of ground cinnamon. While this gave good results, it was decided to experiment and determine whether a better poison could not be developed. After considerable experimenting it was found that there were two forms of poison that seemed to be best. The first consists of corn-meal flour to which had been added 18 per cent of white arsenic and 10 per cent of boneless codfish that had been run through a meat grinder. This mixture was wrapped in small paper packages by a group of small boys, the paper packages were placed in a barrel and sprayed, by means of a hand atomizer, with oil of anise, in sufficient quantity to produce a barely perceptible odor, and then mixed and thoroughly agitated to distribute evenly the oil of anise. If the oil of anise is too strong, the rats do not take the poison well. The second type of poison is the same as the first except that grated Parmesan cheese is substituted for the ground codfish, in the proportion of 5 per cent. When the rats apparently tire of one class of poison and do not seem to take it well, the other is substituted for a time, and in this way the efficiency is maintained. The cheese used is that which has been in the market for some time and is old, yellow, hard, and moldy, and can be bought very cheaply. It is grated by hand on an ordinary grater, producing a coarse sort of powder that can be handled very readily and that mixes well with the corn-meal flour base.

For the purpose of rat extermination chief dependence was placed upon the poison, and this later appeared justified. In the beginning the two inspectors who followed along behind the poisoners to observe the efficiency of the poison reported finding 1 poisoned rat for each 1.75 houses visited. This proportion steadily decreased until the inspectors reported 1 dead rat for each 12 houses visited—an apparent reduction of over 80 per cent as compared with 75 per cent shown by trapping statistics.

Poison operations in interior towns.—As human plague had appeared in the interior towns of Duran, Milagro, Huigra, Daule,

Nobol, and Colimes, in the coast zone, and in Ambato and some of the Indian villages of the mountain districts, it was decided to use poison on a large scale in these places and not attempt to do extensive trapping, for the reason that trapping is more expensive than poisoning, and besides there were no laboratory facilities at hand for rat examination.

The results were prompt and fulfilled expectations. Human plague ceased, as a rule, after the first poisoning, and the mortality among the rats was very high. Instructions were then given that all these places should be thoroughly poisoned once a month. As the towns are small, it requires only from two days to one week to place the poison throughout them, depending upon the size. At the time of this report human plague had not reappeared in any of the towns above mentioned.

It is not known how much poison has been placed in the towns and villages, as no strict record has been kept. It is of interest to state, however, that in the city of Guayaquil alone, in the course of about seven months, over 5 tons of the poison mixture previously described have been placed, and no serious accidents have occurred. It has been stated that a few pigs, chickens, and cats have been poisoned, but there is definite proof that this is unlikely. One small child was said to have been made sick by having eaten some barium chloride, but a talk with the father failed to elicit any information that would tend to confirm this. One woman was said to have eaten one of the packages of poison with suicidal intent, but her life was saved. There has been some resistance on the part of the public to the placing of the poison, but it has been overcome in every instance.

Not only from present experience but from previous experience it may be stated that the use of poison on a large scale, substantially in the manner described, is the most efficient way of destroying rats in cities, towns, and villages. Its use is not attended with serious danger, either to persons or animals, and its application is cheaper than trapping, for the reason that the work can be done with one-half the number of laborers, and expensive equipment, such as traps, bait, carts or trucks, bags, and tags, need not be purchased.

Estimate as to the number of rats destroyed in Guayaquil.—Guayaquil is said to have a population of 100,000. It is usually estimated that the average city has one rat for each inhabitant. Guayaquil must have had many more than this number, for the reason that most of the houses are constructed of light materials, such as bamboo side walls covered with mud or plaster stucco, wooden framing, and sides with double walls and partitions, and many of the houses rent out the ground floors as stores, many of which are food stores, groceries, food warehouses, etc.; and as in very few instances these articles are pro-

tected from rat depredations, it is believed that Guayaquil had a much larger rat population than most cities of its size.

The inspectors whose duty it was to report upon the efficiency of the poison usually reported about as many dead rats as were caught by the traps, and they frequently stated that they were convinced that, on the average, two rats died from the poison for each one found dead. They based this statement on the number of complaints that came from householders relative to bad odors resulting from dead rats between walls and partitions and under floors. (In the beginning of the campaign it was necessary to employ a young man whose sole duty consisted in answering telephone calls and in routing the disinfection gang that dug out these dead rats and disinfected or deodorized the place where they were found.) Also many householders told them of dead rats that had been found and buried, burned, or thrown into the garbage can. Taking all these factors into consideration, it is conservatively estimated that approximately three rats were destroyed by the poison for each one caught in the traps. If this estimate can be considered as fairly exact, it would appear that about 172,000 rats have been destroyed in the city of Guayaquil in a little over seven months.

Laboratory examination of rats.—The existing laboratory was utilized and with the addition of some more materials and equipment was found to be fairly adequate.

All rats delivered by the rat catchers to the laboratory that were in fit condition for autopsy, or were not used for flea studies, were examined. The method consisted in opening the rat completely after tacking it on a board, then making macroscopical examination and inoculating all suspicious rats into guinea pigs. All rats that were not considered suspicious had small pieces cut from their spleens and placed in a mortar, a small amount of salt solution was then added, and the mixture was at once inoculated into a separate guinea pig. This method was used in order to make sure that no plague among rats escaped observation. It was somewhat surprising soon to note that more infected rats were being found by means of the emulsion, or mass inoculation, than were found by inspection. An effort was made to correct this but it met with small success. The conclusion was finally forced that, in all probability, possibly due to acquired immunity from having been exposed to plague for 22 years,[1] the rats of Guayaquil had a form of plague that was apparently transmissible, though unrecognizable by macroscopic examination.

There was a small laboratory at Ambato where rats were autopsied, but as no facilities for microscopical examination existed all material was sent to Quito for examination in the laboratory there.

[1] Possibly due in some cases to the fact that the rats were trapped at a stage when the organisms were too few in number to be recognized in stained preparations or to produce gross lesions of the disease. — *Ed.*

Epidemiological observations made.—As Surgeon Eskey is making a complete epidemiological report,[2] a mere mention of some of the more important observations will be made here.

In Guayaquil the continued presence of plague has been due to a continuous epizootic among the rats. Three types of rats were found, viz, *Rattus norvegicus*, *Rattus rattus*, and *Rattus alexandrinus*. The prevalent flea (over 95 per cent) was the *L.* or *X. cheopis*.

In the cities of the coast zone the types of rats and fleas found were similar to those found in Guayaquil. In the mountain districts the problem was somewhat different. In these districts the disease existed principally in the Indian villages, with cases occasionally occurring in the towns; some of these either were infected in a village to take sick later in the town or were infected from the original case.

The disease was undoubtedly originally introduced into the mountain districts from the coast towns and cities through rats carried on the cars of the Guayaquil & Quito Railroad. On several occasions rats have been caught on these cars, and railroad employees state that they frequently see them, especially in cars loaded with rice, grain, and sugar, or other foodstuffs.

The disease is apparently transmitted from one Indian village to another through the agency of the Indians themselves, for the following reasons: It has been the custom among the Indians for many years, to hold wakes over their dead. The wake is usually held in the hut of the deceased and may last for several days. The attendants at the wake drink large quantities of "chicha," become intoxicated, and sleep on the floor of the hut. As there are infected fleas in the hut, the Indians either become infected or carry infected fleas with them in their clothing to their own villages to start a focus of the disease there. Seeming proof of this is found in the fact that many of the cases are preceded by an epizootic among the guinea pigs that are commonly kept (for food purposes) running around loose in the huts. It is a fairly common occurrence for all the guinea pigs in a hut to die soon after the Indian has returned from a wake, and soon after the guinea-pig mortality human cases occur.

Another possible factor in the transmission of the disease in the mountain districts is the occurrence of two unusual forms of the disease, both highly contagious and infectious. The one is known locally as "viruela pestosa" and is a manifestation of the septicemic form of the disease. It is characterized by a chicken-pox-like eruption composed of vesicles, filled with a straw-colored liquid, that rupture easily when touched. The liquid of these vesicles contains numerous plague bacilli, so that any one touching or handling a patient or a person dead with this form of the disease is extremely likely to become

[2] See PUBLIC HEALTH REPORTS, Sept. 5, 1930, p. 2077.—*Ed.*

infected. It is a common practice at wakes for the Indians to handle, caress, and wash the body of the deceased.

The other form of the disease is locally known as "angina pestosa" and is characterized by a violent form of tonsillitis and pharyngitis, with involvement of the cervical lymphatic glands. It is believed to be due to the custom, existing among the Indians, of killing with their teeth fleas that they find on their persons and clothing. It can readily be seen how infection could find lodgment in the crypts of the tonsils if one of the fleas so killed should be infected. This form of the disease is highly contagious and infectious, just as is the pneumonic type, through coughing and through the discharges from the mouth and nose.

So far as these investigations were concerned little was found to indicate that the rats play any great part in the spread of the disease in the mountain districts, except possibly as the agent which introduces and reintroduces infection from the coast cities and towns via the railroad.

Migrations of rats are known to occur in large numbers at certain seasons of the year. These migrations are coincident with the crop seasons. When the grain is ripening and about ready for the harvest, the rats leave the towns and villages and go to the fields. When the grain is harvested and stored in the houses and huts, the rats leave the fields and return to the villages. It has not been possible so far, however, to establish connection between these migrations and plague outbreaks. Data are hard to obtain from the Indians, and further study of this phenomenon is needed.

The measures recommended and being carried out in the Indian villages consist of periodical posioning to keep the rat population as low as possible, the early detection and isolation of cases, fumigation of huts for flea destruction, the prohibition of wakes in huts (especially huts for the holding of wakes, to be known as "casas de velorios," are being constructed) and better storing of grain and foodstuffs so as to protect them from rat depredations, and frequent visits of sanitary inspectors to all Indian villages.

To prevent reinfection of the mountain districts from the coast, and vice versa, a fumigation station has been established at Bucay, where all freight-carrying trains pass the night, and all loaded cars will be fumigated with Zyklon B for the purpose of rat and flea destruction. These cars no doubt carry fleas, as persons have been bitten during a ride of several hours in a freight car while sitting on top of the cargo.

SUMMARY

It is believed that, for all practical purposes, bubonic plague has been eliminated from Guayaquil and from the towns and villages

situated along the Guayas River and the line of the Guayaquil & Quito Railroad as far as Huigra, situated in the mountain district. It is realized, however, that in order to make sure that plague will not reappear, antiplague measures must be actively continued for one or two years more. This work is being done.

Plague still exists in sporadic form in the central mountain districts and in the Province of Loja. With the prevention of reinfection from the coast, and vice versa, through the systematic fumigation of railroad cars at Bucay, and with the constant application of the measures recommended, it is believed that the disease can be eliminated from the central mountain districts in a relatively short time at a reasonable cost. As the disease has never existed in this district except in sporadic form, its control should be fairly easy, especially in view of the epidemiological knowledge now available that was formerly not available. There is good reason to believe that the prevention of reinfection from the coast zone will in itself contribute greatly to the disappearance of the disease.

CONCLUSIONS

The port of Guayaquil is no longer a menace to other countries through international commerce. If by October 1, 1930, no further cases of human or rat plague shall have occurred, the port of Guayaquil may be reported to the Pan American Sanitary Bureau, in accordance with the terms of the Pan American Sanitary Code, as a "clean port" of class A, as when the regulation period of six months without plague shall have passed it will possess all the requisites that the treaty specifies.

The existence of plague in the interior Provinces, except in the case of the Province of Loja, which is in constant communication with Peru, has no international significance.

Complete and unselfish cooperation was extended by the officials and health authorities of Ecuador, who manifested great interest in this work, and valuable aid was given by their subordinates and employees.

MATERNAL MORTALITY IN THE BIRTH REGISTRATION AREA, 1929

The Department of Commerce announces that for the birth registration area the mortality rate for puerperal causes (7 per 1,000 live births) in 1929 was 0.5 higher than the rate (6.5) for 1927, the last year for which the summary was published. Puerperal septicemia increased less, the rate for 1927 having been 2.5, as compared with 2.6