

PLAGUE IN JAVA, 1910–1912

BY N. H. SWELLENGREBEL

*Instituut voor Tropische Hygiene, Amsterdam*A LECTURE DELIVERED AT THE LONDON SCHOOL OF HYGIENE AND
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I know that you have finished your study in tropical medicine and hygiene at this school. And so, surely, I am not wide of the mark if I suppose there is very little in the way of facts and views you have not, at least, heard of. I think it rather useless to try to add one more small fact, or one more insignificant view, to the hoard of knowledge stored in your brains, or in your notebooks.

So it is, I think, with the subject of the present lecture, plague. You know it from the clinicians point of view, and you know what the public health officer has to say about it. The curiously dualistic aspect it offers: of invariably fatal pneumonic plague, and of bubonic plague with a lethality of 80 % and less; of a frankly contagious disease, spreading directly from man to man, and of one which does not spread from man to man, but from rodent to man, by the intermediary of rat-fleas.

You know all that. You may even correct my somewhat antiquated notions by telling me that pneumonic plague is no longer absolutely fatal, thanks to certain antibiotics—and by pointing out that bubonic plague may be transmitted from man to man. But you will concede, I trust, that transmission, in that case, is not a direct one, but that it is brought about by fleas; human fleas; so, at least, people in Morocco tell us.

But, perhaps, you do not know what people do, exactly, when plague invades their country—you think you do: have you not read reports beginning like this: ‘When the first case was detected in a labourer working in the docks, the most stringent measures were taken, etc.’ Out of respect for your knowledge I shall put it differently by saying: Perhaps you do not know what people did, exactly, when plague reached the island of Java, in the third quarter of the year 1910.

Well, they did nothing—for the simple reason that they were not aware that anything untoward was happening. Plague? There never had been any plague in Java, nor anywhere else in Indonesia. True, there had been a few cases in Sumatra, in the tobacco growers’ area. But it had disappeared as by magic. There was a crank there, straight from Holland, who had never been in Indonesia before. ‘What happened once might happen twice’, he said, and he warned against the danger of plague. He even visited Bombay, to attend the meeting of a congress. All he saw of plague there completely turned his head. He returned to Sumatra raving about rats and fleas, and he was altogether unbearable. And, finally, had not a professor of the Utrecht University said that plague could not enter Java, because no *Rattus norvegicus* was there to open the door for its admittance?

Thus, nobody thought of plague in October 1910. Was there, then, nothing to

warn them that something extraordinary was going on? Something like the events the French novelist Albert Camus describes in his book *La Peste*? Perhaps you have read his description of an epidemic of plague in the Algerian city of Oran. There, the people were certainly warned by extraordinary events; rats were dying in such numbers that the municipal authorities could hardly cope with the task of having the dead bodies removed.

Nothing of the kind happened in Java. No dead rats were found. Even later on, when plague had been diagnosed, when cases of human plague became quite numerous, and when everyone was on the look-out for signs of an unwonted mortality in rats, dead rats were conspicuous by their absence.

What else was there to warn the authorities? People dying from a fever? So many people had died of a fever. Long after the presence of plague had become common knowledge, there was a notorious plague district, called Sisir. All people dying from fever had their spleens punctured, after death, with an injection needle. A smear was made from the material collected in the hollow needle. In the laboratory the smears were fixed, and stained with methylene blue. If no other bacteria were present, coccobacilli showing the typical, slightly asymmetrical, bipolar staining were considered to be plague bacilli. It was a rough and ready method, permissible only to identify subsequent cases, when the first had been carefully diagnosed by a complete bacteriological and pathological examination. Well, in that particular district of Sisir I remember well that fever patients dying within four days showed the most beautiful sporulations of *Plasmodium falciparum* I have ever seen. Plague bacilli were more common in patients who had not died till the fourth or fifth day, or later. So, what did a patient dying from fever matter in that district? It was the commonest thing in the world, and it reminded no one of plague.

Of course, this state of things did not last for ever. A correct diagnosis was, no doubt, retarded by the extraordinary prevalence of severe cases, with a case fatality of 90 %, or over, and a short duration of the illness, which did not leave time for the buboes to develop. It was also retarded by the fact that most victims were found among the common people. Well-to-do Indonesians were rarely affected, white people almost never. Still, the common people materially helped in arriving at a correct evaluation of the state of things by becoming scared, and showing it, on rare occasions, by evacuating their village. Smallpox, malaria, cholera did not scare them away, although morbidity and mortality due to these diseases was considerably higher than it ever was in plague, even at its worst. But with these other diseases the people were well acquainted, whereas here was a new disease, entirely unknown to them. The common people were really the first to diagnose plague, not as plague, but as a new, dread disease, requiring extraordinary measures to repel it, like the images of demons painted on the walls of houses to be protected.

Thus warned, and aided by the occurrence of typical bubonic cases, medical authorities finally succeeded in diagnosing cases of plague. By that time the disease had invaded the whole of eastern Java, about one-quarter of the area of the island. Whether that invasion had been immediate or had found time to develop

in the five or six months of ignorance of its presence, and where the disease had entered the country, will remain for ever unknown. It is generally accepted however, that the main port of eastern Java, Surabaya, allowed the plague to enter into the island.

Once the presence of plague in the island had been ascertained, the question was asked how to confine it to the area it had already occupied, and how, eventually, to get rid of it altogether.

As it was a new disease, no one knew anything of how to handle plague, except for the facts published in international literature. Practical knowledge there was none. The reports of the Indian Plague Commission, published in the *Journal of Hygiene*, well known to you no doubt, were the main sources of information.

This gave rise to a serious controversy. One party was formed by the Health Officers, the hygienists, with de Vogel to lead them, who every night studied the Indian Plague Reports like their Bible. The other party were the general practitioners who visited the patients in their villages.

One party considered all the Plague Reports said as gospel truth, and acted accordingly. To them plague was a disease of rats; man was of minor importance. Rat plague was the hidden stolon, growing steadily under cover. Human plague was the offshoot, springing to light and betraying the presence of the hidden stolon. Human cases did not arise one from another, they all had a common cause: rat plague.

Nevertheless, they knew that man can take part in the spread of the disease. He may do so in three ways.

First, by developing a secondary pneumonia in the course of septicaemic plague, thus starting an epidemic of pneumonic plague. Cases of septicaemic plague were by no means rare; at least cases believed to be so, because of their short duration and the absence of buboes. Thus, the danger of pneumonic plague could not be excluded. Its prevention required the ordinary quarantine measures, based on the assumption that plague is a contagious disease. 'Bubonic plague is not', the health officers said, 'but it may become so. Let us take no risks.' I may say at once that this danger of pneumonic plague, eventually, proved of small importance. Tiny epidemics of that disease flared up now and then. The patients and their families were carefully isolated in small camps, protected by barbed wire, prepared for their reception. In no instance was any further spread noticed.

A second possibility of a plague patient becoming an immediate source of infection to his fellows was not considered at that time. I am referring to the transmission from man to man by human fleas. Experiments carried out by the Indian Plague Commission were supposed to exclude this possibility. In our days there are investigators who doubt whether the Commission's experiments were conclusive. Nevertheless, this neglect on the part of the Health Authorities in Java was of no importance whatever: (1) because compared with conditions in Europe or Morocco human fleas are rare; (2) because other measures, taking account of rat-fleas only, were, nevertheless, counteracting the spread of plague by human fleas—supposing that such a thing was really happening.

A third possibility of man spreading plague was advanced by the Indian Plague Commission, and, consequently, had the full attention of the Health Authorities in Java. It is the transport of infected rat-fleas from one village to another. Not, however, of rat-fleas carried on the bodies of their natural hosts, rats of various kinds, but on the body of man, who carries infected rat-fleas in his clothes or in the luggage he takes with him. At a time when stringent quarantine measures had to be abandoned, the possibility of man carrying rat-fleas remained an object of close attention. It induced the health authorities to maintain the sanitary cordon isolating the whole Division of Malang, for a long time the principal site of plague. It had two places of egress or entrance only. At first all people leaving the Division were detained for five days, and their clothes and luggage were subjected to bacteriological disinfection. Later on they were detained for no longer than was necessary to kill ectoparasites in their clothes and their luggage.

The main object, however, of the Health Officers' attention was the rodent population. They were convinced of the truth of the Indian Plague Commission's teachings. Rats, to them, were the main source of plague. Thus, regardless of expense, they organized a rat-hunt on a grand scale.

The whole population was encouraged to lend a hand, by a reward of a half-penny for every rat delivered at the office of the Commissioner, the Head of the Division, or his subordinates. Now things began to look like Camus's description I referred to just now. With this difference, however, that the heaps of rats, accumulating near the various offices, were not killed by plague but by man. An elaborate organization had to be devised to burn all these dead rats. Later on the halfpenny was paid on deliverance, not of the whole rat, but of its tail only. For the sake of convenience the applicant for the reward was required to deliver the tails in packages of a 100, neatly bound up with a string of rattan, for which he collected two shillings and tenpence. At first the packages were closely examined as to the quality and the quantity of their contents. But the subordinate officials, detailed for receiving the packages, very soon learned to assess their value by their size and estimated weight. This neglect (for neglect it was) gave rise to all sorts of fraud. There even was a thoughtful artisan of Chinese extraction who manufactured beautiful imitation tails. He sold them at one shilling a package, bound up within one layer of real rat tails. Later on he even discarded that one precaution against detection; it served his purpose just as well.

Special teams were employed in catching rats in plague-stricken villages. These rats were delivered at the plague laboratory in the town of Malang, the capital of the Division of that name. There they were examined for signs of plague infection, with the object of ascertaining the extent of rodent plague. This investigation was also extended to villages free from plague, in order to trace the direction in which rat plague was spreading in advance of human plague.

This investigation, continued for several months, and comprising thousands of rats, was carried out in a way with which you are conversant, no doubt. The rats are put side by side on long tables, fixed by the fore- and hind-legs, the abdomen slit open, a smear of the splenic pulpa is made, fixed, stained with methylene blue, examined for the presence of bipolar-stained coccobacilli. Positive cases are subjected to a complete bacteriological examination.

This work of the bacteriological laboratory led to a disconcerting, I might almost say a shattering, surprise: not a single one of all these thousands of rats was found infected with plague. Nor was there ever a rat brought to the laboratory that was reported to be found dead. All rats examined had been killed by man.

Just now I mentioned the existence of two contending parties: the party of the Health Officers, and the party of the general practitioners. Up till now I have been telling you of the first party only. But the absence of rat plague gave the other party their chance. They reasoned like this:

‘Look here’, they told the Health Officers, ‘we do not deny that the Indian Plague Commission is right—in India. But you are wrong in applying their conclusions to Java. You yourself have proved that plague does not exist in rats in this country. We visit the plague patients in their homes, you do not. So we know all the peculiarities of the way plague is occurring in these Javanese homes, of the way it is spreading within one family and from one family to another, and of the way it is attacking each patient. All that knowledge you have not the means of collecting, because you have other things to do than to visit the patients in their homes—whether these other things are worth doing we will not discuss at the moment. And that knowledge has convinced us that plague in Java, unlike plague in India, is a contagious disease. Early detection of the patient and early isolation of him and his family is the method to stop the epidemic. Rat hunting is nothing but expensive child’s play.’ The public were all in favour of the general practitioners’ point of view. It satisfied their sentimental humanitarian feelings; the doctors risked their lives (so they thought) visiting distressed families and bending over plague-stricken patients, who look up to them with their flushed faces, with that peculiar expression of anxiety, which some believe to be so characteristic in plague. You will readily understand that the Health Authorities had a very embarrassing time.

And now I must recall to your mind that eccentric person, fresh from Holland, who, six years earlier, had predicted the advent of plague in Indonesia, on the ground of a few cases in eastern Sumatra which were gone before it was properly realized that they were there.

That man, van Loghem by name, had done a piece of most unpromising research in eastern Sumatra. In the absence of plague he had taken on the subject of rats as the next best. He had shown that some of the eastern Sumatra rats which a Leyden zoologist had identified as *Rattus norvegicus* were not *R. norvegicus* at all. True, their tails were shorter than their bodies, and they had six teats on their thorax; but their skull was quite unlike *R. norvegicus* and more like *R. rattus alexandrinus*. Moreover, this rat, later on identified as *R. brevicaudatus*, does not live in burrows near human habitations like *R. norvegicus*. It burrows in the fields, where it feeds on the produce of the fields. Only when the crops are harvested, and the fields lie fallow, it visits the houses for food.

Of course, nobody was interested in this piece of mammaliological systematics.

That was some years before plague broke out in Java.

When tidings of the calamity which had befallen Java reached Holland van Loghem offered his services to the Government. Of course they accepted his offer; he was the only man who knew about plague, by his visit to Bombay in 1908. And

so he came to Java in the spring of 1911, as staunch a supporter of the Indian views as de Vogel himself. In Malang he came face to face with the general practitioners, who held exactly opposite views.

They told him of the position in which the hapless Health Department found itself, of the practical certainty that rats had nothing to do with plague, as far as the Division of Malang was concerned. Van Loghem told them of a small experience of his own during his visit to Madiun, the most western town of eastern Java, where a few cases of plague showed at varying intervals. There he had been shown a house in which a patient had died from plague the night before. On the baleh-baleh (native couch, made of bamboo), from which the corpse had just been removed, he found a dead rat, afterwards identified as a rat which had died from plague. Twenty-two rat fleas (*Xenopsylla cheopis*) were collected: on the rat's body and on the baleh-baleh next to it.

The doctors were not impressed. 'It may be so in Madiun', they replied, 'here in the Malang Division, where there is much more plague, we find nothing of the sort.' To reinforce their viewpoint they took van Loghem to the plague laboratory. They showed him the long rows of rats, spread-eagled on the wooden tables for inspection. 'Look at that, Mr van Loghem', they said, 'you might have seen the same every morning for weeks at a time, and never a single plague rat has been found.' 'All from plague-stricken villages?' van Loghem asked. 'All from plague-stricken villages,' they confirmed. 'All from human habitations?' van Loghem further asked. 'All of them,' was the reply.

Van Loghem came near the table. He took a pair of forceps. With it he caught hold of the tip of one of the tails hanging over the table's edge. He lifted it and laid the tail lengthwise over the body of the rat to which it belonged. It did not reach the mouth of the rat. He repeated the same manipulation with another rat, and still another, taking care this time to select females; the same result. Finally, he examined a few females which showed well-developed thoracic teats; he counted three pairs of them. Then he asked two more questions: 'Paddy is still on the fields?' 'Oh, yes, the harvest will not be till May.' 'And the rice barns, are they full?' 'No, they are empty. People are short of rice just now.'

Then van Loghem looked up: 'These are all field rats. And they have been collected in the fields.' Great indignation among the doctors; van Loghem was quite wrong, all the rats were caught inside human habitations. 'Did you catch them yourself, or did you see them caught there?' inquired van Loghem. Of course they had not. How could they find leisure to do anything of the sort, when all their time was taken up with visiting the sick? But they would satisfy him by calling in the chief rat-catcher.

Enter the chief rat-catcher, greatly scared because he was convinced that he had been detected in appropriating part of the money destined for rewards. When finally he had been convinced that nobody doubted his unblemished character, he was ready to answer questions. If you are conversant with the course such questioning usually takes I shall tell you nothing new by the following summary:

Q. Are all these rats caught in houses?

A. Yes, all of them.

Q. Was it difficult to catch them there?

A. Extremely difficult.

Q. How, then, do you succeed in catching so many?

A. Because my men work night and day.

Q. When do you catch most of them, by night or by day?

A. Sometimes by night, sometimes by day.

Q. How do you catch them? When they are running about, or in their nests?

A. While they are running about.

Q. I see a number of baby-rats among this catch. Were they also running about?

A. No, we caught them by digging out their burrows.

Q. Where were these burrows?

A. We found them in the little earthen causeways between the rice fields.

Q. But that was not inside the house?

A. It was near a house.

Q. Were the other rats also caught inside their burrows?

A. No, they usually ran away when the burrow was dug up, and they were clubbed when running.

Q. But that did not happen inside the house?

A. It happened near the house.

Q. Was it very near the house?

A. The village was well in sight. (Here I may add that there are always at least three villages in sight, whatever position one takes up in the rice fields).

Q. Were any of to-day's rats caught anywhere but in the burrows in the rice fields?

A. They were all caught there.

Q. But I told you to catch rats inside human habitations. Why did not you do so?

A. I did, I caught them all near human habitations.

Q. But that is not the same: I told you to catch them inside the houses.

A. There are no rats inside the houses.

The interview was much longer. It was, moreover, interspersed with repeated asseverations that he had not appropriated any public money. This is only a summary. But the outcome was this, that none of the rats examined up till that time had been caught inside the habitations of persons suffering from plague, nor in other houses in plague-stricken villages, nor in houses of any other description. All the rats examined were field rats, i.e. rats burrowing in the fields, and showing by their morphological characters that they did so, even before the chief rat-catcher had the confirmation wormed out of him.

The physicians were by no means convinced. They granted that the negative findings of murine plague were not as convincing as they had believed them. But they still held strongly to their belief that rats had nothing to do with plague in the division of Malang. Only field rats existed there, and they were exempt from plague. As to plague in house rats, it was no use talking about it, since there were no house rats—had not the chief rat-catcher said so himself?

Van Loghem held that the functionary's statements had definitely proved

unreliable in the first instance, and that there was no reason to believe him more reliable in the present one. So, it was decided next day to visit the recently plague-infected village of Karangloo, to convince van Loghem that there were no house rats—or the physicians that there were.

The next day they found themselves in front of a house just evacuated by the inhabitants because of one of them having died of plague. They were to stay in a quarantine camp for five days. Their clothes and bedding had been disinfected.

All the furniture was now removed from the house, while it was surrounded by a cordon of men armed with sticks to kill any escaping rats—but there was none.

Next the house was taken to pieces. That is not a serious matter in a Javanese house in those parts. It is composed of bamboo beams, erect and horizontal. The roof is covered by palm leaves, and the walls are composed of prefabricated squares of bamboo matting. No nails are used, all fastening is done by means of rattan strings. One can take it down like a doll's house, and put it up at the same place, or any other, provided one digs holes in the ground to hold the vertical beams.

A great many spiders were disturbed. You know them, the big ones, *Heteropoda venatoria* by name, $4\frac{1}{2}$ in. across, including the legs—but no rats.

There lay the house, bamboo beams and squares of bamboo matting. The physicians were jubilant. Van Loghem was dismayed. Were there, really, no house rats? He was sure there must be. He firmly believed that the Indian research workers were right. And he could not conceive that epidemiology of plague in Java could be *that* different from India.

There was a thick bamboo beam lying at his feet. You know, such a beam is hollow, the hollow inside the beam is divided into compartments by partitions. That particular beam was cut off in such a way that the hollow was closed by a wall of partition situated at both ends of the beam. Van Loghem noticed a piece of red rag sticking out of the beam. Looking closer, he saw that the rag was protruding from a hole piercing the wall of partition. He tugged at it and it came out, together with a few shells of groundnuts.

On this, the beam was cut lengthwise in halves. There the two halves lay, each one showing the partitions and the compartments they separated. All partitions were pierced; in some of them nothing remained but the outer rim. All compartments were filled with pieces of rag, together with groundnuts, cotton seed, maize grains and other edibles—and dead rats. One was quite fresh, two others had swollen bellies, the remainder were mummies. Later on it was possible to isolate plague bacilli from the first one, also from the black stinking mass which once had been the spleen of one of the other two. All three were females, the fresh specimen had a tail distinctly longer than the body, and four pectoral teats. You would have called it *R. alexandrinus*. We call it *R. diardii* over there. It is a house rat, also a ship rat, but never a field rat. The others were too far gone to be identified.

All beams were split. Only the big horizontal beams supporting the roof, and at the top of the roof, contained rat nests and dead rats; eighteen dead rats altogether, fifteen mummified. The physicians objected to including the mummies in the count. They said these rats must have died weeks before plague appeared in

Karanglo. Perhaps they were right. Later, in Semarang, it was shown that rat plague preceded human plague by an interval of five months. But de Raadt proved that mummification is complete after one week. Then one can take the mummy at the tip of its tail and it will stand out, inflexible, as hard as a piece of cardboard.

From now on similar observations were made in other villages, once it became known where to look for dead rats and their nests. Trapping in carefully baited traps also revealed the presence of live rats, especially in villages exempt from plague. Plague rats, also live ones, began to find their way in ever-increasing numbers to the laboratory, for which van Loghem had brought a full bacteriological equipment, and which now was working at top speed. Rats with short tails and females with six pectoral teats, the only ones before van Loghem's arrival, were no longer seen on the dissecting tables. There were none but long tails and females with four pectoral teats.

You will understand that, since this experience, I do not believe in the absence of plague rats in epidemics of bubonic plague.

It was something to have silenced the opposing party, the infidels to the Indian creed. But it was a greater thing that these hectic days had brought the solution of how to deal with plague. Soon van Loghem convinced de Vogel that this was a problem of how to construct the house so as to prevent rats nesting within it. It lies not within the scope of my lecture further to enlarge on this point. I only want to add that rat-proofing the house had to be complemented by rat-proofing the inhabitants, i.e. educating them to cleanliness and order, so as to render the contents of the house as unattractive to rats as the house itself.

Van Loghem's researches, which I have quoted from my memory of the happenings of the first days, renewed confidence in the Indian results. Man was no longer considered a source of infection. Nevertheless, disinfection of his clothes and luggage on leaving infected areas was not discarded, because of the possibility of the export of infected rat-fleas. The application of this measure was ensured by the existence of the sanitary cordon around the Division of Malang. This cordon was not too onerous, because the Division was mainly self-supporting. But it became highly onerous when a single town became a centre of infection, and had to be isolated by a sanitary cordon, as happened to the town of T. Agung. Although importation of food was allowed, and a certain amount of intercourse between people inside the town and outside continued, conditions soon became unbearable.

The commissioner of the province, in which T. Agung was situated, asked the city health officer to explain to him why the cordon was necessary notwithstanding plague was said not to be contagious. The health officer gave the required explanation. Then the Commissioner drew the following conclusion from the data explained to him: In this town numerous people are walking about carrying rat-fleas in their clothes or their packages, some of them infected. If these fleas are carried to a village, in the neighbourhood or farther off, where the murine population has not been decimated by plague, the imported rat-flea will have no difficulty in finding its natural hosts. If it was infected it will start a fresh epizootic and eventually an epidemic.

When the City Health Officer had approved, the Commissioner became Napoleonic: 'Go and find me these rat-fleas on man, they need not be infected fleas, so long as they are rat-fleas'. The poor Health Officer had no notion of how to carry out this order. But the Commissioner told him how: 'I shall give you a squad of policemen. You go to the market, and you collect a hundred men at random. It will not hurt them, for there is nothing to buy, nor to sell. You take them to the hospital, let them undress and put on hospital clothes. In the meantime you have a big wooden chest lined with clean sheets. You put in all the clothes you collected, and any packages they were carrying. You pour in all the chloroform you can lay hands on. Close the chest. Seal the seams with sticking plaster, and leave the chest closed for as long as you like—and show me the rat-fleas you collect.'

The orders were carried out conscientiously, the chest having remained closed for three hours. A quantity of lice, human fleas and bed-bugs were collected, but no rat-fleas.

Thereupon the Commissioner decided that the sanitary cordon was no use, and had it immediately withdrawn. A wise decision no doubt; based, however, on an extremely slender foundation.

The same experiment, but on a larger scale, was repeated at the two stations of disinfection, where people were allowed to leave or to enter the Division of Malang. In three months' time nearly 57,000 people passing these stations had their clothes and luggage disinfested by putting them into a chest of 9 cu.ft. made of zinc and sprinkling them with 125 ml. of sulphide of carbon. The chest was opened after one hour, the clothes taken out, shaken over a white sheet, and the objects falling off the clothes collected.

The only ectoparasites collected in any quantity were lice (about 2000), bed bugs (about 700) and human fleas (about 200); but there were two *Xenopsylla cheopis* and one *Stivalius cognatus*, both rat-fleas, among them.

Obviously, not all these people came from plague-infected villages, and still less from plague-infected houses. Thus, the chance of any one of them carrying rat-fleas could only be very small. The fact that we found a few, nevertheless, undoubtedly strengthened the Indian theory of the spread of plague by human intercourse, although it did not prove it.

Disinfection of the clothes of 1829 inmates of plague-infected houses, including 393 patients (still alive, or dead from plague), might be expected to yield more rat-fleas. It actually did: seven rat-fleas (all *Xenopsylla cheopis*) on 2000 persons against three rat fleas (two *X. cheopis*) on thirty times as many people. Nevertheless, the number of rat-fleas collected in these favourable circumstances was so small as to render the advisability of continuing the sanitary cordon extremely doubtful. As a matter of fact it was withdrawn shortly after these results became known.

It might have been different if the rat-fleas had been found infected after grinding them up and smearing them on the shorn abdominal skin of guinea-pigs. But there were too few of them, never more than one at a time, to render the consistently negative results anything but inconclusive.

For, although at that time (1912) little, if anything, was known of the result of collecting ectoparasites supposed to be infected with plague, grinding them up, and inoculating them into guinea-pigs, we at least knew that a positive result may depend on the number of insects one has pooled. The lice we collected on the inmates of plague houses, pooled in batches of from 7 to 250, and inoculated percutaneously in guinea-pigs, proved infected in 7 batches of 250, 70, 50, 40, 24, 13 and 11 and non-infected in two batches of 55 and 7, whereas two batches of 2 and 3 *Cimex rotundatus* proved negative.

Even after so many years I am not sure the Health Authorities were right in withdrawing the sanitary cordons. When plague reached central and west Java it would have been impossible to maintain them. Even before that time it would have been extremely difficult to have cordons around the smaller foci, which would have been necessary to render the measures effective, supposing they could be effective anyway.

On the other hand, the observations on the subject although inconclusive, proved that the principle was supported by facts. Moreover, incidental observations, which had nothing to do with that principle, proved that man was actually infecting his lice. Why should he not infect his fleas as well?

But these are idle thoughts. Plague has spread over the whole of Java, but rat-proofing, after the initial onslaught, has kept it well under control. The war-years, however, have shown renewed activity.

This is a description of the initial trials and errors people usually omit when writing their final report. That final report on plague in Java has been written. How rat-proofing of houses became the backbone of anti-plague activity, joined with the education of the people, coming to live in the new houses, I termed 'rat-proofing of the inhabitants' just now. Finally, inoculation against plague with Otten's live vaccine came to serve the purpose of bridging that awkward interval, of six months or thereabout, between the time the epidemic started and the moment rat-proofing was beginning to take effect.

I have taken you behind the scenes, and told you about mistakes made and redressed. Perhaps in years to come you may make a mistake, and it may hearten you then to think other people did the same.

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