

pite of such a favorable climate, Méng-tái, in common with other parts of Yunnan, has suffered annually for a period of years from the plague, a kind of malignant fever, fatal in a few days, having as one of its symptoms a hard swelling in the neck, in the armpits, or in the groin, which has carried off a number of its inhabitants. On approach of the epidemic, the first victims are rats, which, fearless of human beings rush madly into their presence, and after capering around the soon fall dead at their feet.* From Yunnan the disease traveled to Pakhoi by one of the common trade routes, where according to Lowry and Hoeder, it has been endemic for over twenty years. In 1891, it broke out in Kao-shao, later in towns situated on the West River, and finally in 1894, a severe outbreak occurred lower down in Canton. Now, the infection of Hong-Kong proceeded either from Pakhoi or Canton; but inasmuch as Pakhoi is more than three times as far from Hong-Kong as Canton, and the Hong-Kong commerce with the latter port is hundreds of times greater than that with the former, it is probable that Canton was the source of contagion. Supporting this view is the following significant fact: On the second of March, 1894, a large Chinese procession was held in Hong-Kong, which was attended by over 40,000 Cantonese coolies of the lower class.

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At this period, tens of thousands were dying of the plague in Canton, and accordingly it is not improbable that the island of Hong-Kong was inoculated thus.

The first cases appeared in the district of Tai ping-shan where the sanitary conditions are worse than in any other part of the city. (Properly speaking the city is called Victoria and the island Hong-Kong, but the latter name is now customarily used for the city as well.) In the native and European quarters of the city, Hong-Kong presents a strange contrast, for the European districts, from a sanitary point of view, are probably unexcelled in any city in the Orient; but the native quarter, notwithstanding some fairly broad, clean streets and new buildings, is really a whitened sepulchre. Here, in the tenements and side alleys, the coolies live in indescribable filth; the segregation and overcrowding being so great that at night the overflow sleeps in the streets. Many of these in the native districts are so narrow that one walking with outstretched

arms can almost touch the buildings on opposite sides of the road. The houses are three or four stories high and originally contained fairly large-sized rooms. The Chinaman, however, with his naturally frugal mind, subdivides these by cheap wooden partitions, and makes four rooms for one. With the decrease in the size of the rooms goes an increase in the number of their occupants, so that in one poorly ventilated tenement from 20 to 40 natives are huddled together, with less than 150 cubic feet of air-space per capita. As yet the coolie has not learned even the rudiments of personal hygiene, and the Chinese enjoy the unenviable distinction of being one of the filthiest peoples on the face of the earth. Apropos of this trait, some one has fully called them practical Malthusians. One day in Hong-Kong we counted 14 coolies pulling and pushing a meat-cart that could have been drawn easily by a single horse; so, in a country where man and the horse show in a commercial ratio of 14 to 1, little in the way of civilization or personal neatness can be expected. As a rule the common coolie never cleans either himself or his houses.

In speaking of these questions Lawson* says: "At the beginning of the outbreak a majority of the houses were in filthy condition. When to a mixture of dust, old rags, ash, broken crockery, moist surface soil, etc., is added fecal matter, and the decomposing urine of animals and human beings, a terribly unsanitary condition of affairs prevails; and that this is no overdrawn picture of what was to be met with in Tai-ping-shan, many Europeans now know to their cost." One must recall, moreover, that Hong-Kong is Europeanized China, and that the conditions prevailing there do not compare with those found in Canton, for example—a typical Chinese city like those in other parts of the colonial Empire. Indeed, in comparing it with Canton, there is something almost Utopian about the sanitary condition of the native quarters of Hong-Kong.

Once begun, the epidemic was fought by the following general sanitary measures: (1) Removal of the sick and dead. (2) Temporary segregation of those exposed while the premises were being disinfected. (3) Cleansing and disinfecting

* Lawson: J. The Epidemic of Bubonic Plague in 1894. Medical Report, Hong-Kong, 1895.

of "infected premises." (4) Disinfection of clothing. (5) General cleansing and lincwashing of all tenement houses. (6) House-to-house visitation. (7) Disinfection of public latrines. These measures were all carried out with a considerable degree of success—much more success than attended the similar ones established later in India. This is due partly to the fact that the Chinese is more easily bullied by sight of power than the Hindu, and partly because the customs offered by the plague regulations are, in China, for the most part merely personal and are neither national nor religious.

During the height of the epidemic the medical staff had more to do than it could accomplish, but by the aid of a number of British soldiers, especially assigned to plague duty, managed to keep up the routine work necessitated by the sanitary plague regulations. In this work the greatest opposition came from the unwillingness of the Chinese to send patients into the hospitals and the resistance they made to house-to-house inspection. In the secretion of cases, moreover, they often went to unusual extremes, and the district inspectors in their search for patients often saw sights that it seems almost impossible to believe. Dr. Lawson says, for example: "To overpaint the pitiable surroundings associated with plague work at the commencement of the epidemic would be impossible. I have entered a long, low cellar, without any window opening, and with air entering only by a square open shaft from the level of the roof three or four stories high. Down one side of the shaft ran a broken earthenware drain-pipe, leaking freely, the contents streaming down the wall of the air-shaft to a shallow pool of filth which crossed the ungrazed floor of earth. Although it was broad daylight outside, a lantern was necessary to see one's way. On a miserable sodden matting, soaked with abominations, there were four forms stretched out. One was dead, the tongue black and protruding. The next had the vascular twitchings and a semi-comatose condition heralding dissolution. In searching for a bubo we found a huge mass of glands extending from Pott's ligament to the knee-joint. This patient was beyond the stage of wild delirium. Scabs covered the teeth and were visible between the blackened and parted lips. Another sufferer, a female child about 10 years old, lay in the accumulated

filth of apparently two or three days, unable to speak owing to the presence of enlarged cervical glands. The fourth was wildly delirious and was constantly vomiting. The attendant—the grandmother of the child—had a temperature of 103° F. and could only crawl from one end of the cellar to the other. She was wet through and was herself decessed. This is no fancy sketch but a true picture of how we found some of the patients at the outbreak of the plague in Hong-Kong. No one unfamiliar with the horrors of the squalid accommodations in China, could credit how the poor live in Hong-Kong, or could imagine how the horrors of their everyday life were intensified by the plague." In disinfecting some infected premises one day Dr. Lawson told us that in one room the inspectors were forced to dig through two feet of dirt and human excreta to reach the floor.

The mortality from plague in Hong-Kong among the Chinese varies between 91 and 93 per cent, so that almost all of those afflicted, no matter what their treatment, die. Naturally, in view of these facts it is not astonishing that the

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coolies rebel against sending their sick into the hospitals, for there the tremendous mortality is emphasized much more than it would be in cases that remained at home. Both in the Tung-Wah Hospital and Kennedytown Hospital for infectious diseases, wards are set aside where those who elect may receive native treatment. Of course, this practice amounts to a recognition of the quackery of the Chinese doctors on the part of the government, which thus officially assumes the responsibility for their treatment. This practice is now being strenuously opposed by the Colonial medical men.

During our visit to Hong-Kong, the plague was quiescent and there were only from 16 to 20 deaths a day from the disease. The house to house visitation at this time had been given up, so that the majority of these cases were found dead on the streets and were carried by the inspectors to the mortuary. On entering the morgue each morning the sight was a ghastly one, for the bodies were lying about on the tables waiting until the hasty autopsies, necessary for burial, could be performed. Many that had not been discovered promptly were fly-blown, while other cadavers that had for

several days been lying undiscovered in obscure places were half-eaten by maggots before they were carried to the mortuary. The disposal of cases that die after successfully eluding the vigilance of the district inspectors is facilitated by the habit which the coolies have of sleeping on the streets during warm nights. In Hong-Kong, during the hot season, night shows many weird and picturesque sights. The life narrow streets in the native



DR. JAMES A. LAWSON, CHIEF PLAGUE OFFICER AT HONG-KONG, IN FRONT OF THE KENNEDYTOWN HOSPITAL.

quarters, lighted dimly by the flickering street-lamps are simply covered by the sleeping coolies who are drawn from the crowded and poorly ventilated houses by the stifling heat. They are so crowded that one cannot walk for any distance without stumbling over the half-naked sleepers who lie stretched out on little pieces of matting. So when a suspected plague patient dies, he is carried out by relatives and laid in the street among the sleeping forms. Most of these rise at dawn

to go to work, and those that do not are usually taken later to the mortuary by the plague inspectors.

The mortuary is situated half-way up the hill on the outskirts of the city toward Canton, and consists of a modern deathhouse, an office for the government medical officer, and quarters for the native care-taker. The first striking thing about the plague bodies was the presence on many of two parallel rows of deep purple spots about the size of a Spanish dollar extending from the sides of the neck down on to the chest. At first sight these appeared to be a new manifestation of the disease until Dr. Lawson told us that these purpuric spots



SMALLPOX WARD AT THE KENNEDYTOWN HOSPITAL.

were the result of the Chinese method of counter-irritation. This consists in firmly pinching the skin between the thumb and forefinger until it is bruised. As there is, in plague, a general tendency to hemorrhagic extravasation into the skin and serous membranes, the blood oozing from the torn vessels into these traumatic areas soon turns black, and gives the appearance which we first noted. Mosquito and flea bites behave in much the same manner. Likewise the slightest scratch or bruising of the skin is apparently always followed by a pink blush, and later by a subcutaneous hemorrhage which soon changes to a dark purple-colored spot. In many cases we observed extensive bullae filled with blood-stained serum, and

in one or two instances the idiopathic hypodermic hemorrhages which gave the disease its medieval name of the Black Death.

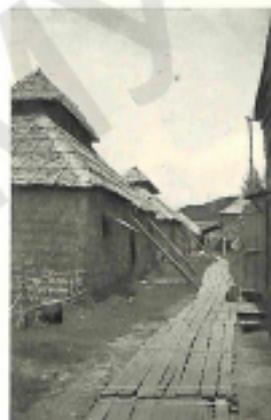
The main plague hospital in Hong-Kong is now at the old Kennedytown Barracks, in the extreme outskirts of the city, which have been converted into a hospital for infectious diseases. Here principally plague and smallpox cases are received. The hospital occupies a commanding position at the foot of Mount Austin, from the base of which the grounds extend to the water's edge. The main building, a substantial stone structure overlooking the mouth of the West River towards Kowloon, is covered by stucco, and contains the laboratory, offices and a few wards. The major part of the hospital, however, consists of rude matsheds made of palm-thatched walls and roof stretched over bamboo frames. They have rough board floors, and are lined by coarse matting. On the whole they make a fairly hygienic hospital, except that thorough disinfection of the wards is impossible. A few

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supported on piles over the water's edge are perhaps more sanitary than the rest, because they get air and sunlight in greater abundance. As a rule these wards are large enough for four or five patients, their small size being a decided advantage, as convalescents and those in the early stages of the disease are thus kept from witnessing the depressing scenes that often occur when patients are in the delirious stages of the malady. Plague patients do not have beds or cots but lie on a platform made of boards, supported by ordinary carpenter's horses, over which is spread a small oblong piece of matting. They have no bedding, and their heads rest on the peculiar Chinese pillows which look more like bamboo rat-traps than anything else. When patients get in the maniacal delirium that often accompanies the acute stage of the disease, they are tied down on their rough litters by cloth thongs. A patient so controlled can be seen in the accompanying photograph. In the male wards there are coolie attendants while the women are nursed by ayahs. Besides the Kennedytown Hospital, there were during the days when the epidemic was at its height several other temporary hospitals established in the city, and a floating hulk, the *Hygieia*, nicely fitted up and anchored off the Kennedytown Hospital, was used for European and Japa-

nese patients. Aoyama, the Japanese physician who was infected from an autopsy, wound, was treated on this ship.

Epidemics begin in the bubonic form, and when the epidemic is at its height and the mortality is greatest, changes to pneumonic plague, and finally in the defervescence stage dies off again in the bubonic type. This has occurred regularly in Hong-Kong, and has been noted in the many epidemics that have occurred in India by the plague authorities there. Atroc-



A ROW OF PLAGUE WARDS IN THE KENNEDYTOWN HOSPITAL.

spheric conditions do not seem to have much influence on the disease, except that during the rains, people are driven into the crowded, dirty houses, where they are more exposed to infection; and the bacilli, moreover, are protected under these circumstances from the desiccating and bactericidal action of the sun's rays. This, Kitamoto has shown, is one of the most potent agents in the destruction of the plague bacillus, exposure for an hour usually being quite sufficient in temperate climates to destroy the germ. Epidemics are usually heralded,

by a great mortality among the rats, which seem, when affected with plague, to lose all fear of human beings and run boldly



WATCHTOWERS AT THE KENNEDYTOWN HOSPITAL, WHERE NATIVE TREATMENT IS GIVEN.

about the houses. In part, at least, the infection of the rats can be accounted for by the ingestion of septic material, &c.,



PLAGUE PATIENT UNDER RESTRAINT IN THE HONG-KONG PLAGUE HOSPITAL.
spatium and dejects of plague patients, but by far the most pro-

The cause of its spread is by fleas. It is well known that fleas soon leave the bodies of rats dead of the plague, and it is supposed get on to other healthy uninfected rats. The agency of these insects as transporters of the disease has been shown by Stenrod* and by Lowson who got fleas from plague rats on healthy rodents, and found that they died of the disease in about three days. Flies and mosquitoes, however, do not seem to play such an important rôle in the transmission of plague to human beings, for both infest the wooded area about the Kennedytown Hospital, and yet no one of the attendants there

was ever infected. By far the most important mode of infection for human beings are through abrasions of the skin, through the mucous membrane of the respiratory tract, and to a lesser degree through the alimentary tract. Plague, like any infectious disease, thrives where sanitary conditions are poor; and in China and India finds naturally ideal conditions for its spread among the hordes of natives whose lives of misery and squalor form the dark side of the human picture in the Far East.

The symptoms and bacteriology of the pest have already been well described in the translations of the papers of Kitazato and Aoyama which appeared in this journal some years ago† so reference will be made only to some of the more important points which were brought to our attention in India and China. It appears that the disease may exist in any of its forms alone, or two or even more may simultaneously complicate each other in the same patient. In the simple tubercle type the location of the bubo indicates that the portal of entry of the infection occurred in the area drained by that set of lymph-glands, but it is also not uncommon to find glands enlarged *en cobailon*. Thus, in one of our Hong Kong autopsies the femoral, inguinal, iliac and lumbar groups were all enlarged and hemorrhagic. From the observations made at the Arthur Road Hospital in

* Simon: "Propagation de la peste" *Annales de l'Institut Pasteur*, Oct., 1898.

† Flexner: *Bulletin of The Johns Hopkins Hospital*, Vol. VII, Oct., 1896.

— *Bulletin of The Johns Hopkins Hospital*, Vol. V, Oct., 1894.

Bombay, based upon the study of a large number of cases, the site of the buboes occurred as follows:

Femoral,	35.13	per cent.
Femoro-inguinal,	33.36	" "
Axillary,	16.35	" "
Inguinal,	12.98	" "
Cervical,	5.25	" "
Multiple,	4.67	" "
Total	94.13	" "

The frequency with which the buboes occur in the lower sets of lymph-glands is explained by the fact that both in India and China, natives of the lower classes go barefoot. But in this connection it is worthy of note that all of the men in the Shropshire regiment in Hong-Kong who were attacked with the plague while on inspection duty had femoral or inguinal buboes, even though they were well-booted. Their trousers, however, were open at the bottom, admitting dust particles laden with plague bacilli. While on similar duty in India, the soldiers always wore puttees, and not a single case was reported among them.

In most cases the buboes are exquisitely tender and generally require local applications to relieve the pain. For this purpose the ice-bag has been used with good effect in India. Between the portal of entry and the enlarged glands, there is often a well-marked lymphangitis and at different points multiple lymphatic abscesses may occur. This was particularly marked in Aoyama's case. When we met him in Japan, he showed us the scars of the numerous incisions made to relieve the condition about which there was a slight tendency to the formation of keloid. This has been repeatedly observed in Hong-Kong among the Chinese who have recovered after a complication of suppurating buboes or lymphatic abscesses. Most of the buboes do not suppurate, but the fact that the great majority of cases die within two or three days after the onset undoubtedly bears a relation on this point. Likewise, it seems that mixed infections have a very important influence on the question of suppuration as the following figures show. In the pus of 29 suppurating buboes examined by the several

continental commissions working in Bombay, the following results were obtained:

Bacillus pestis,	8
Staphylococci,	9
Streptococci,	5
Sterile,	7
Total,	29

A suppurating plague bubo forms a most indolent ulcer and the granulations at the base sprout with such reluctance that it may take months for them to heal. Fortunately in these old chronic ulcerations the pus is usually sterile. In one case in Hong-Kong, followed by recovery, the femoral vessels lay exposed in the base of a large slough about a suppurating bubo.

The incubation period in plague varies between three and nine days, but in the majority of cases averages about five or six. It seems that there are no constant prodromata, and the onset, as a rule, is sudden, marked by headache, fever, backache, and a general feeling of malaise. Vomiting of a blood-stained fluid has been observed not infrequently at the onset, a phenomenon due to the action of the plague toxin in the mucous membrane of the stomach which, at autopsy, is nearly always injected and ecchymotic. In Hong-Kong, they were in the habit of speaking of the plague facies, which Lawson believes is often of assistance in the diagnosis of the disease. It consists of a mixture of anxiety, cyanosis, and dyspnea, and in mentioning it Lawson says: "Generally speaking, there is something indescribable in the face of the plague-stricken which seems to help your diagnosis—an expression as if the sufferer himself knew all about it, and his inner consciousness had left its mark upon his features." There is something quite characteristic about the plague tongue, which has a hoarier coating than in typhoid fever and is considerably clearer about the margins. Sores the coating turns black and scabs often cover the teeth and lips. After the onset the fever usually rises rapidly and reaches its maximum in from 12 to 24 hours. The common temperature ranges from 100° to 105° F., but cases with a fever as high as 108° are not infrequently observed.

The patient soon after the onset shows evidence of great

prostration. The pulse, at first, is full and bounding, and later becomes feeble and collapsed. Diarrhoea is very common, and the heart, in the majority of cases, needs repeated stimulation to overcome the cyanosis. The cardiac symptoms observed clinically in plague cases conform in general to the results obtained experimentally by the injection of the toxic nucleoprotein of the Pest bacillus into animals. Lustig and Galeotti have also shown* that the subcutaneous injection of

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large amounts of the plague toxin into animals is followed by a local thrombosis at the point of inoculation, and that the blood-pressure in dogs falls rapidly to 10-15 mm. of mercury, accompanied by a progressive diminution in the force and rhythm of the heart-beats soon resulting in death.

On the second or third day, the cerebral symptoms usually appear: these consist of a general apathetic condition on the part of the patient, coma or delirium of varying degrees. During this period it is often difficult to get the patients to take nourishment, and the attendants must resort to strategy or rectal feeding. This was notably the case with Doctor Aoyama, who could only be tricked into taking nourishing draughts by appealing to his politeness, or the one hand, and his patriotism on the other, by alternately tasting Queen Victoria and the Mikado in champagne, milk and other nourishing and stimulating beverages. During this period of the disease symptoms of meningeal involvement and cerebral hemorrhages were sometimes observed.

The respiratory symptoms in most cases consisted of a marked hypostasis owing to the marked cardiac weakness; but when the pneumonic type of plague was present, the condition was more often of a lobular type. In uncomplicated cases the plague bacillus can be found in the sputum, but oftentimes there is present a mixed infection with the pneumococcus. Edema of the glottis and extensive laryngitis were also found in some of the Bombay cases. During the course of the disease, as well as at the onset, vomiting occurs and the vesicles in such cases is stained with both bile and blood. The spleen is palpable and remains so during the course of the disease. There is always

* Lustig and Galeotti: *Lo Sperimentale*, 1908.

some albumin in the urine, but it is small in amount; likewise casts, epithelial debris, and occasionally Plague bacilli are also found. In general the disease runs its course in five or six days, but the fever may remain elevated for weeks especially in cases where there is a secondary pyemic infection. Death in most cases occurs from heart failure. No cases of reinfection



ONE OF THE PLAGUE STREETS, POONÉ.

above suspicion have been reported, but relapses are not uncommon during convalescence and result usually from local extension from the original focus of the disease.

Between the plague in China and India there are many points of difference which depend, it seems, partly on the character of the natives. In China the pest is more fatal than it is in India, the death-rate among the Chinese being 85 per cent, and only about 80 per cent among the low-caste Hindus, who are the

hardest sufferers from the disease in India. The general standards of life and personal hygiene are much lower among the Chinese than they are among the Hindus; but for some reason the epidemics are so much greater in India that the terrible effects of the disease are more obvious and its many horrors are impressed on the observer by the magnitude of the sufferings of the natives. Since the first outbreak in India, in 1896-7, the death-rate has constantly increased each year, until, in 1898, more than 50,000 people died of plague in the City of Bombay alone. Moreover, the disease has now spread in a



PLAGUE FUNERAL IN INDIA.

large part of India and has appeared in Bengal, Madras and many points in the Bombay Presidency. The really serious part of the question is that apparently it is still on the increase, and precisely what the end will be no one at present can foretell. The Colonial Government, however, is doing all in its power to stamp out the disease, and no experiment is left untried that offers the slightest hope of solving this very serious question.

The plague measures in India are much like those in Hong-Kong except that they are, perhaps, not quite so thorough. In India the plague authorities have had to fight against the bigotry, opposition and animosity of the native who gives far more trouble to the sanitary authorities than his colonial

neighbor. Here exist the ideal conditions for the spread of any disease; namely, overpopulation, overcrowding, malarialities, unhealthy environment and crude and unclean methods of living. Under these conditions the energy required to fight the plague in India has been tremendous because of the inertia of the vast population, which ever looked with disfavour on the measures meant for its good. In Bombay alone, the plague

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WARD IN PUNA PLAGUE HOSPITAL. THE PATIENT COVERED WITH A BLANKET IS DEAD.

expenses for the first year of the epidemic amounted to over fifteen lakhs of rupees.

Certain facts concerning the plague epidemics of India have been more fully described in another place;* but the methods of treatment employed in India and the results obtained in their use are of the greatest importance. No effort or expense has been spared by the Indian government to try any method that offers any hope of relieving the distressing conditions.

* Barker and Flint. "A Visit to the Plague Districts of India." New York Medical Journal, Feb., 1906.

To this end, the Bombay Presidency has fitted up the old government house at Parel as a plague laboratory, and here the plague prophylactic of Haffkine and Lantig's *Heiferum* are manufactured. Yersin, it appears, was the first to manufacture a serum supposed to act as an antitoxin to the poisons produced by the plague bacillus. Like the diphtheria antitoxin it was made on the assumption that the plague toxins were soluble products of the growth of the pest bacillus and could be obtained from filtered fluid cultures of the organism. The first cases treated by the antitoxin were in China and the results, it is stated, were very satisfactory. Somewhat later several plague patients at the Arthur Roads Hospital in Bombay were inoculated with the antitoxin, but the results were practically negative; so, from lack of both results and material, further experiments with Yersin's serum were not undertaken. In the *Operte epidemie Calmette's* used Yersin's serum and reports excellent results with it. Two facts, however, should be noted, i. e., that the number of cases treated in India was too small to allow any conclusions as to the real value of the antitoxin as a therapeutic agent to be drawn, and, on the other hand, that the cases occurring in Portugal were by no means so severe or fatal as those among the natives of Bombay.

Then some time later Haffkine,† making experiments along the same line reported to the health commissioner that his efforts to obtain an antitoxin for plague by methods similar to those used by Behring, Kitasato and Roux for diphtheria were unsuccessful and that his experiments resulted negatively. At a later period Lantig and Galeotti‡ had a similar experience, but they found, however, that the essential toxin was situated in the body of the plague organism and was of the nature of a "nucleoprotein fraction." They succeeded in isolating this toxin by the following method: A three days' growth of the plague bacillus on large agar plates is scraped off and dissolved in 1 per cent KOH. This solution is filtered and acidulated

with dilute acetic acid, whereupon it yields an abundant white precipitate which is washed and dried and in this state can be kept indefinitely. It is prepared for use by dissolving in a dilute solution of sodium bicarbonate (0.5 per cent). This *nucleoprotein fraction* is soluble in alkalis and insoluble in dilute acids. In general it gives the protein reactions and by artificial digestion can be split up into peptone and an insoluble nuclein. When injected experimentally it produces the symp-



LOW-CASTE HINDU DEAD, POONA HORTICULTURE.

oms which we have already described. It is from this *nucleoprotein fraction* that the antitoxin is manufactured by injecting it into a horse. The quantity used naturally depends a good deal on the condition and strength of the animal. The injection is followed by a violent reaction at the site of inoculation; an area of localized oedema half as large as a man's head may persist at the point of inoculation for many days. We saw that condition in one of the horses at the Parel Laboratory in Bombay. These large injections are repeated as often as the condition of the horse permits until the required degree

* Calmette: *Presse Médicale*, 1899.

† Report on the Outbreak of Bubonic Plague, 1896-97. Bombay, 1897.

‡ Lantig and Galeotti: *La Spérimentale*, 1898.

* Galeotti: *Arch. des Sciences Biologiques*. Tome VIII, 1899.

of immunity is produced. When the serum is withdrawn and prepared in the usual way. As yet the number of antitoxic units has not been determined by animal titration, and the preparation of the serum in large quantities has only just begun. The complete reported results thus far include 175 inoculations, with 100 deaths, and 75 recoveries, or a mortality of 57.50 per

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cent. Thus, the mortality for plague averages about 73.75, so that, at present, the serum saves about 14 per cent of the cases.



CHILD DEAD OF PLAGUE, POONA HOSPITAL. PREPARATION FOR FUNERAL.

In these inoculations the cases were not selected but were taken as they came, and included 18 in which dissolution was imminent. After the injection a hypothermic action was noted which occurs in plague cases to be a specific reaction, as it was never obtained when people who were not suffering with plague were inoculated. At times considerable prostration seemed to follow the injection and a slight increase in the cardiac weakness so that coffee, camphor or ether were often given with the antitoxin. After the second injection there was an amelioration of the conditions. The antitoxin, according to Galeotti, acts in a manner exactly opposite to the *urogenesterin foetivus*. The pulse becomes less frequent and the diuresis disappears; there is an augmentation in the force of the heartbeat, while

the buboes, at the same time, become less painful, and any tendency to suppuration is arrested. Bacilli, moreover, tend to disappear from the blood. In pneumonic cases and in the severer gastro-intestinal infections, the antitoxin is its present strength apparently has no effect.

Soon after the outbreak of plague in India M. Haffkine, formerly of the Pasteur Institute, who had been at work in India on some problems concerning cholera, began the preparation of a prophylactic against plague.* The principle involved in the preparation of that fluid is similar to that followed by Listig somewhat later in the manufacture of his *Wollorox*; namely, that the plague toxin resides in the body of the pest bacillus, and cannot be obtained from the soluble products of its growth. The preparation of the Haffkine prophylactic fluid is now carried on, on a large scale, in Bombay; and it is shipped all over India and to many other parts of the world. At present the prophylactic meets with great opposition from the natives, especially the Hindus, who will not submit to inoculation because the fluid contains meat, and thus offends one of their most cherished religious principles. To meet this objection an effort is being made to procure a medium on which to grow the organisms from a substratum gluten and other substances free from meat extracts.

The manufacture of the prophylactic is quite simple, and through the kindness of Dr. Helme, who had charge of the Pasteur Laboratory in Haffkine's absence, we were able to follow the prophylactic through the various stages of its preparation. A kilogram of finely chopped goat's flesh, after macerating in hydrochloric acid, is placed in an autoclave and heated for six hours under a pressure of three atmospheres. This is then filtered and neutralized with KOH and diluted up to three litres, when it becomes the medium in which the plague bacillus is grown. Some plague material is put into three flasks and the bacillus is identified by what Haffkine has described as the staphylococcal growth. If such cultures rest absolutely un-

* Haffkine: The plague prophylactic. *Ind. Med. Gazette*, June 1887.

— Remarks on the plague prophylactic fluid. *Ind. Med. Jour.*, 1892, Vol. 12.

disturbed for five or six days, after being inoculated on the surface, fine delicate thread-like processes can be seen hanging from the surface into the depths of the bacillon which have a very strong resemblance to the stalactites that hang from the roof of a grotto. This growth, according to Haffkine, is pathognomonic of the plague bacillus, and the purity of such a culture can be tested microscopically. The culture is put into a Pasteur flask, from which a large series of 3-litre flasks are inoculated after it is certain that the original culture is uncontaminated. These are grown in a large, darkened room,



MOHAMMEDAN GIRL BEING EXAMINED BY THE HOSPITAL AUTHORITIES.

containing long tables on which hundreds of these 3-litre flasks rest. Owing to the high mean temperature thermostats are unnecessary in India. To make the prophylactic it is necessary to get repeated crops of the stalactites in each flask and to keep the surface inoculated; a small amount of sterile "glue," a sort of clarified butter, which fuses on the surface and always contains after the original inoculation a few bacilli, is added so that after repeated stakings the surface of the culture is always re-inoculated. In this way five or six crops of stalactites are obtained before the serum is finished, and this takes, as a rule, about six weeks. After

agitating the flasks, the little clumps of bacilli sink slowly to the bottom and a new surface growth slowly appears. The culture is killed by immersion in a constant water-bath at

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70° C. for three hours when some carbolic acid or thymol is added, and while care is taken to keep it well shaken the prophylactic is decanted into small bottles and is then ready for use.

The usual dose of the plague prophylactic was about 3 cm., but at Hukli, where it was used most extensively, Leuzman* was in the habit of using a greater quantity at each injection.



BURNING GHAÛ, POONA PLAGUE HOSPITAL.

He always took into consideration, however, the age and physical condition of the patient in making the inoculations. An ordinary antitoxin syringe is used for this purpose and the injection made well into the subcutaneous tissue. Injections into the skin are apparently more painful than those made well below the corium. After two inoculations with the plague prophylactic the blood of the patient usually gave the Widal reaction. This, however, is not obtained so readily after a single protective injection. Leuzman allows from 14

* Report No. 2508, of 1905

to 20 days to elapse between the first and second injections, and regards the constitutional reaction of headache, fever and malaise as more important than the agglutination test. Extremes of age do not seem to affect the value of the inoculation, as on one occasion a child 10 days old was inoculated while on another, a woman of 90 was protected against the disease. Women as far advanced in pregnancy as the seventh month were inoculated without the occurrence of any unfavorable symptoms, a fact which is rather interesting when one considers that all pregnant women taking the disease itself abort. To avoid, as far as possible, the injection of the protein in the incubation stage of the disease, it was regarded a safe rule not to inoculate any one with a temperature of 100° F. until it was certain that he was not suffering from the plague.

Since it has now been generally recognized that, under the conditions which obtain in India, the hygienic and sanitary measures have little or no effect in influencing the course of the epidemic or lessening the mortality from the disease, the results obtained at Hubli have been most successful and gratifying. In all some 78,000 inoculations were done in a period of four months in Hubli, in the province of Dhárwār, many of which were, however, on the inhabitants of the outlying districts and villages. It seems that the double inoculations have a greater protective power against the disease than single injections of the prophylactic, which statistically is shown to amount to 10 per cent of the total mortality among the inoculated. But in Dhárwār the results were even better than at Hubli; for there were, among 4,320 single inoculations, 45 cases and 15 deaths; and in 3,387 double inoculations, 2 cases and 1 death.

Moreover, among these inoculations were undoubtedly included some cases where the prophylactic was given to those in the incubation period of the disease. Hubli, where the Haffkine serum received its first large and comprehensive test, is a mercantile town of about 50,000 inhabitants. It was attacked by the pest at the beginning of the monsoon rains, and the average monthly rainfall between October and April reached 28 inches. Although a large health camp was established, and as many plague regulations as possible were put in

force, it was evident that the authorities could not cope with the epidemic, so they determined to make a thorough test of the prophylactic. Mr. Cappell, the collector of Dhárwār, says: "If this experiment had failed, the mortality, judged by the actual mortality among the uninoculated, would have been appalling. All possible sanitary measures in the shape of disinfection, muzzling of horses, and segregation were applied concurrently with the inoculation as the government is already aware; but the rate of mortality among those who held back from inoculation rose at one time to a height which, I believe, has never been approached elsewhere—standing in the third week of September at the figure of 457 per thousand per week."

The duration of the protection afforded by the serum could not be definitely determined, although the majority of the citizens were protected for at least 5 months. In 69 households, all of the inoculated members escaped the disease while some of the uninoculated in the families succumbed to the disease. Perhaps a more conclusive idea of the scope of the enormous experiment may be gathered from the appended table, which shows that at only one period did the non-inoculated have a percentage advantage over the inoculated in the mortality tables and that was when the epidemic was not severe and the number of the inoculated was low.

DATE.	Number of non-inoculated in Hubli.	Number of inoculated in Hubli.	Deaths from Plague amongst		Percentage of cases of	
			Non-inoculated.	Inoculated.	Non-inoculated.	Inoculated.
Five weeks from 12th May, 1906, to 14th June, 1906.	34,772	501	47	1	44.2	—
WEEKLY RESULTS						
21st June, 1906	31,034	2,229	22	1	15.2	100.0
28th June, 1906	32,012	1,656	24	3	14.1	100.0
5th July, 1906	30,028	5,168	55	2	12.1	100.0
12th July, 1906	33,276	7,289	91	2	12.1	100.0
19th July, 1906	28,716	9,699	92	6	10.0	100.0
26th July, 1906	21,112	10,111	100	9	10.0	100.0
2nd August, 1906	21,003	12,600	100	9	10.0	100.0
9th August, 1906	15,594	15,215	272	11	10.0	100.0
16th August, 1906	14,089	15,191	306	25	10.0	100.0
23rd August, 1906	6,987	20,592	37	29	over 100.0	100.0
30th August, 1906	4,094	26,617	152	29	over 100.0	100.0
6th September, 1906	2,771	28,071	22	21	over 100.0	100.0
13th September, 1906	1,139	30,201	113	23	over 100.0	100.0
20th September, 1906	503	31,083	106	21	over 100.0	100.0
27th September, 1906	681	31,272	58	31	over 100.0	100.0