ON THE BUBONIC PLAGUE.

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On the Bubonic Plague. By Dr. Alex. R. Ferguson.

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In bringing a subject of this kind before the notice of this Society, I feel that it is one in which interest and concern are alike awakened—those calamitous events recently seen in India, in connection with the disease of which it treats, constituting its most emphatic claim on our consideration.

Of the many epidemic forms of disease by which different parts of the world have been at one time or another dominated, to the extent almost of depopulation, none have been so long known, so strenuously guarded against, or so much dreaded, as that known as the Oriental or Bubonic Plague.

Although evidence is not wanting that the disease had been known in certain parts of India and China practically from time immemorial, yet amongst the earliest records, the details of which are sufficient to enable the nature of the disease to be determined, must be mentioned those which refer to a pestilence occurring in Lybia, Syria, and Egypt in the third century B.C. It apparently made its appearance in Europe in the sixth century A.D., when certain parts of the Roman empire were invaded by it. Indeed, it had not disappeared from Italy and its subordinate provinces until, by means of very widespread sources of infection, the whole of Europe was submerged by what may be literally termed a tidal wave of death in the fourteenth century, whereby it is estimated that not less than 25,000,000 persons perished. All are now agreed that the *Black Death*, or "*Great Mortality*," as it was called in Southern Europe, which so completely overcasts the history of this century, is identical in its features with a very fatal and highly infectious form of plague still present, though happily on the wane, in Bombay. There is little doubt that the main source of infection causing this mediæval epidemic originated in China, though plague centres in India may have

contributed to its spread. From these *foci*, especially the former, infection was carried along the main caravan routes. From China, these ran through Central Asia, keeping well to the north of the Caspian Sea, and thence by way of one of the Black Sea ports to Constantinople, which at that time constituted the main centre of communication between Asia, Europe, and Africa. Europe was thus exposed simultaneously to a source of infection travelling in a westerly direction overland from the south-east portion of Russia, and to infection borne to its various ports by trading ships from Constantinople. Other caravans went from India through Asia Minor to cities along the southern margin of the Caspian Sea, so that a European infection from Indian plague centres also is more than probable.

Numerous epidemics of plague, which continued to be recorded in the fifteenth and greater part of the two following centuries, show with what difficulty the disease was eradicated from European soil, and it was only towards the close of the seventeenth century that it receded slowly eastwards. In London, as is well known, it raged unchecked till the great fire of 1666, which removed to a large extent its haunts of infection, but did not extinguish it, sporadic cases occurring in the city and district till 1679.

It is worthy of note that plague finally disappeared from Europe in that district into which it had been at first imported, viz., the south-east of Russia. Plague as an endemic disease only vanished completely from Europe in 1878-79, up to which time certain villages on the Volga had been subject to periodic outbreaks of the infection.

In certain parts of India and China, however, plague has never been wholly extinct, the records of both countries showing the occurrence of epidemics at intervals of a few years from the earliest times to the present day.

With regard more particularly to Bombay, which, as is well known, has been infested with plague certainly since the beginning of September, 1896, and probably earlier, authorities are generally agreed that, as an endemic condition, it does not exist in this city. It is, therefore, necessary to determine by what route it may have reached Bombay. Without considering in detail the other possible sources of infection, it will suffice for our purpose to state that in all probability Hong Kong must be, in this instance, regarded as the "*fons et origo*" of infection.

This is supported (1) by the fact that plague was certainly prevalent in Hong Kong at the time, though not in such an actively epidemic form as a year or two previously; (2) that many persons resident in Bombay, who had travelled to Hong Kong on business, were allowed to return to the former city; (3) that, apart from passengers, ships are peculiarly liable to convey infection by harbouring rats, these animals being, as we shall afterwards note, peculiarly susceptible to plague; and (4) that the disease in Bombay made its earliest appearance amongst a certain class of men employed at the Bombay docks in connection with the Hong Kong steamers.

Before proceeding to a short description of the symptoms of plague, it will be well to mention that plague cases of all kinds may be conveniently divided into—

I. Cases of all degrees of severity characterised by buboes.

II. Cases of pneumonic type, giving rise to an illness very like an extremely acute inflammation of the lung.

III. Cases of an abdominal type, producing an illness resembling in many respects typhoid fever.

I. In the first variety, or bubonic plague strictly so-called, the patient feels feverish, out of sorts generally, and complains of pain in one axilla or groin. The seat of pain, which is at first red and exquisitely painful to touch, shows in the course of a few hours a tense swelling. This is connected with the abundant lymphatic glands of the region affected, and undergoes in later stages a considerable enlargement and softening. Many other glands become similarly involved within a comparatively short time, and, with a general aggravation of other symptoms, the patient's condition has become critical.

II. In the second, or pneumonic variety, the symptoms are those of the onset of an acute pulmonary disease, and differ in no striking respect from those which usher in an attack of pneumonia, the degree of fever and illness of the patient being, however, out of all proportion to the lung mischief present, which may be relatively insignificant. We may note in passing that the vast majority of cases occurring in the fourteenth century were of this type, the description of symptoms at that time, both by medical and non-medical writers, constituting a graphic picture of the

condition as seen at present. One of the medical writers* of the sixteenth century thus speaks of it as

> "A dreadful pest, before unknown,
> Which seized the lungs, and made the breast its throne,
> Four days it tyrannised with dreadful sway,
> When life in purple streams broke out and fled away."

The expectoration of blood in this form is an early and tolerably constant symptom, and it is to this fact probably that reference is made in the latter part of the above quotation.

III. Cases of the abdominal type of infection have only within comparatively recent times been differentiated, and probably for this reason, as well as their close resemblance to certain other forms of abdominal disease, especially typhoid fever, and some of the remittent fevers of India, constitute a minority of the cases of plague recently seen. Thus it is more than probable that a certain proportion of cases certified as remittent fever, which underwent a sudden and notable increase during the prevalence of plague in Bombay, must be placed within the category of the latter disease.

From a general survey of the facts just detailed, the conclusion is not difficult to reach that the specific cause of this long-known and much-dreaded scourge is some form of living *contagium.* This was felt to be the case more than sixteen years ago—long before the discovery of an organism associated with the disease was announced. At this period Dr. Hirsch, of Berlin, maintained that, for the development of the disease and the formation of a plague centre, there is always required the access of the specific virus of plague, and that these centres are co-extensive with the limits of diffusion of the virus. This opinion, shared by many, has received since 1894 the fullest confirmation in ascertained fact. In this year the announcement of the discovery of a specific micro-organism as the cause of plague was made independently by Kitasato and Yersin, whose researches were carried out at Hong Kong during the then prevailing epidemic. The organism, which is now well known in many laboratories at home and abroad, has the form of a minute rod, and is usually, therefore, termed the plague bacillus. In comparison with most

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* Fracastorius.

of the other disease-producing bacilli, that of plague may be spoken of as a short, thick bacillus. An approximate idea of its dimensions may be conveyed by the statement that 10,000 of them placed end to end, or 25,000 side by side, are required to cover a linear inch. The bacillus has distinctly rounded ends, and stains well by any of the simple aniline dyes in common use, *e.g.*, fuchsin or gentian violet. A fact to be noted in stained preparations of the bacillus is that the terminal portions of the rod are stained much more deeply than the central zone—a characteristic to which the term "polar staining" is applied. Further, the existence of a capsule of quite appreciable breadth, in the form of a faintly-stained homogeneous envelope surrounding the deeply-stained poles of the bacillus, can usually be determined. As in the case of other encapsuled organisms, however, the bacillus loses this structure when grown under artificial conditions in the laboratory. The bacillus has no inherent power of motility, and careful examination has failed to reveal the existence of any mechanism, *i.e.*, flagella, by which locomotion might be possible. The existence of spores also has not been demonstrated. In common with the other members of the large class of organisms to which it belongs, its multiplication is caused by fission—a slight increase in length—and the appearance of transverse septa or divisions characterising the bacilli during the process. Each of these subdivisions afterwards becomes free as a young bacillus, capable of undergoing the same change. This process, even under artificial conditions, proceeds with incalculable rapidity. Several of the characteristic features of the bacillus, to which attention has just been directed, are well illustrated by this micro-photograph [photograph handed round], taken by Dr. Bitter, of Cairo, and by the lantern slide prepared by Dr. Arch. Young in the Pathological Institute of the Western Infirmary. [Slide shown on screen.] The growth of the bacillus takes place readily on the usual nutritive media of the bacteriological laboratory, especially on ordinary peptone agar. On the latter medium, after 24 hours' incubation at 100° F., the growth is apparent as a greyish-white, moist-looking film, not unlike that of the bacillus of typhoid fever recently shown at a meeting of this Society, but differing somewhat from this in the fact that the separate colonies of the bacillus are dotted over the surface of the medium in the form of minute round plaques, which only become confluent towards the lower portion of the tube. [Culture shown.]

The activity of the growth of the bacillus, although vigorous when freshly implanted on artificial media, declines steadily in course of time, so that a re-inoculation on a fresh tube of nutrient agar, from one containing a culture whose age is three weeks or thereabout, frequently proves incapable of perpetuating the growth. Along with this diminution in power of growth a notable decrease in degree of virulence is observed, and it is not too much to say that a laboratory culture of the plague bacillus, obtained by successive inoculations from a parent stock, possesses little, if any, actively virulent power. As a point of considerable practical importance, it is to be noted that while the bacillus is capable of growth at a comparatively low temperature (60° F.), yet it is easily destroyed by heat—two hours at a temperature of 136° F., or a few minutes at 212° F., sufficing for this purpose.

In the body of an infected person the bacillus is found, as a rule, in situations corresponding closely with the morbid conditions which it produces. Thus, in the buboes or swellings of lymphatic glands, which characterise the majority of plague cases, the bacillus occurs in immense numbers, and virtually in a condition of pure culture, while in the spleen they are fairly numerous.

In cases of the pneumonic type the lung *alveoli*, or air-cells, and expectorated matter contain the organism in abundance.

It is only in very severe and rapidly fatal cases in the human subject that they can be found in the blood during life by microscopic examination. In the blood of the smaller rodents, however, the bacillus can be demonstrated in immense numbers.

The division of cases of plague into the three clinical types which we have mentioned—viz., the bubonic, the pneumonic, and the abdominal—correspond generally to three possible modes of invasion of the body by the bacillus. These are—

I. *Through small wounds and abrasions of the skin.* In this way one or two medical men have suffered during the epidemic still in progress in Bombay, having been inoculated through wounds received while making *post-mortem* examinations in plague cases. Experimental inoculation of the disease in monkeys showed that they contracted it typically, though the point of entrance of the virus could scarcely be detected with the naked eye.

II. *By inhalation*, in which case, naturally, the pulmonary system bears the brunt of the infection.

III. *By ingestion with the food*, in which the mesenteric glands associated with the intestine are involved.

In reading the records of plague, as seen both in ancient and modern times, we are driven to the conclusion that dirt, overcrowding, and defective drainage have everywhere, and at all times, co-operated as a powerful alliance in its propagation.

In these respects, "a more favourable hot-bed for the development and dissemination of the disease could neither possibly exist nor be imagined than the town and island of Bombay." This applies, with particular emphasis, to the native quarter, in which plague first broke out. "These are to a great extent built on "made soil," much of which was originally impure material, including what has been used in reclamation in the vicinity of the docks. Blocks of buildings, several storeys high, were rapidly run up some years ago without proper connections with the sewers, and only surface drains in many places to carry off the surplus sewage and soakage which the ground could not absorb, the solid excreta being removed in baskets on sweepers' heads to the nearest night-soil cart, which, when full, is drawn by bullocks, to be emptied into the main drain at Carnac Bridge or elsewhere. The pollution of soil and atmosphere in such circumstances may perhaps be better imagined than described." *

In concluding this paper, which presents merely an outline of the subject, a reference must briefly be made to the results obtained by a mode of treatment now much in vogue in connection with specific infectious diseases of all kinds. In order better to comprehend the nature of this mode of treatment, allow me to call your attention to such facts as the following:—Cultures of most pathogenic microbes, after being grown under not altogether favourable conditions, undergo a certain diminution in virulence, so that, when introduced into the body of a susceptible animal, the effect produced is very much less than that which follows an injection of the same organism under other circumstances. Such cultures are said to be "attenuated." It has been found, for example, that a series of injections of cultures of the cholera spirillum, of successive degrees of attenuation, is followed by a

* *Brit. Med. Jour.*, Feb. 13, 1897.

condition of comparative immunity against cholera. In other words, the injection of what was formerly a lethal dose of a culture of normal virulence is now followed by a slight, transitory effect, or even by none at all. "Such a method can be preventive, but can never be curative, as the immunity must be developed before the onset of the disease. Immunity of this kind is comparatively slowly produced, and lasts a considerable time, though the period varies in different cases."* Again, if a high degree of immunity be conferred on an animal by the method above described, it is found that the serum of such an animal is capable of exerting an antagonistic or neutralising influence when injected into another animal along with the organism (or its products) in question. The serum of the immunised animal is thus capable of conferring a certain degree of immunity on another animal. It is important to note that this immunity is conferred even though the second animal has been infected before receiving the injections of serum. This latter method has thus a curative action.

Haffkine's mode of treatment, which is entirely prophylactic, is based on the first of the methods described. Its aim is the establishment of a certain degree of immunity against the plague by means of injections of cultures of the plague bacillus, whose vitality has been destroyed by subjecting them to a temperature of about 60° C. It is gratifying to note that of 8,142 persons treated by this method in Bombay up till October, 1897, only 18 were attacked by plague.

The results given in connection with Yersin's anti-plague serum are equally encouraging, though the precise value of both methods must be based on results involving their greatly extended application.

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*Muir and Ritchie, "Manual of Bacteriology."