RATS IN RELATION TO PLAGUE.

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IV.

THE connexion of domestic rats with plague requires for its elucidation some further remarks on the distribution and life history of the tick, *Hyalomma aegyptium*, and also on the cattle diseases referred to on p. 624 of the BRITISH MEDICAL JOURNAL. It is necessary to mention certain points indicative of the possibility of the transference of a cattle-seuche to rats and men by the agency of ticks.

Although Burmah has up to the present not suffered severely from plague, the more recent returns indicate a tendency to invasion of that province. It will be interesting to note if this invasion coincides with an invasion of *H. aegyptium*, which has hitherto not been found in Burmah, although several species of ticks from that country have been recorded by Professor Neumann.

Dr. Yersin¹ records plague as existing in Yunnan from March to July yearly since 1871. Previous to that date the record is not reliable, but tradition points to outbreaks of plague having occurred in Yunnan frequently in the past.

It has been observed above that *H. aegyptium* has not yet been noted from Yunnan. The epizootics also of this province remain for future investigation. In the neighbouring province of Tonkin, however, bovines have been considered² to suffer from "peste bovine," attended by an enormous mortality. Dr. Yersin's note indicates that it was only after the administration of a serum prepared for the "peste bovine" first observed that a difference was noted in the disease affecting cattle and buffaloes, the serum proving efficacious in diminishing the mortality of the cattle but less so in the case of the buffaloes. Later, barbone among buffaloes and pasteurillose bovine among cattle were found to exist. These epizootics are at present under investigation in the Bacteriological Institute at Nhatrang (Annam).

I have no information regarding the cattle diseases of Mongolia, which is an area where plague appears to be endemic.³ It appears in August and September and disappears with the cold, when both ticks and marmots hibernate.

The Mongolians have long been familiar with a disease of rodents which they call "peste de tarabaganes" (*Arctomys bobac*). As *Arctomys bobac* ranges from Kamtschatka to North Germany,⁴ and as it does not suffer in Europe from this "peste" there must be some local cause for its suffering from that disease in Mongolia. The marmot has been observed in Thibet, but there is as yet no evidence that it suffers there from peste.⁵ The Thibetan marmots do not appear to belong to the species under consideration, but that of course is no reason why they should not ultimately be found to suffer from plague. In connexion with this liability of *Arctomys bobac* in Mongolia to peste it may be noted that the larvae of ticks often pass the period before their first moult in the fur of wild rodents. Thus *H. aegyptium*, which is present in the region, would be brought into contact with the natives who capture marmots for food or other purposes. The nymphs would also be brought into the homes of the Mongolians by the same means, and would thus be an efficient vehicle of plague from an infected marmot to man, even if the ordinary means by which man acquires ticks indicated below were not as usual in existence.

Dr. Zabolotny noticed in Mongolia a form of human plague which he had not seen in India. He calls it the pustular form; on the surface of the skin small limpid vesicles appear surrounded by a zone of red hard skin. After twenty-four hours the vesicles become clouded, and contain microbes enclosed in phagocytes. Two days later in the centre of the pustule appears a black spot surrounded by a red zone. In two cases he was able to fix the point of entry of infection which much resembled these spots. He attributes the mechanism of infection to insects, such as flies, bugs, flees, lice (op. cit., p. 840).⁶

I may here refer to the remarks⁷ made by Drs. Calmette and Salimbeni on lesions of the skin in plague. A case is recorded of a patient in the Oporto epidemic having been bitten by a bug (it is not stated whether the bug was seen); the bite became the site of extensive necrosis. There is, they say, a particular form of peste, recognized as far back as the Middle Ages, and also by the German and Austrian savants in Bombay, in which the primitive lesion is represented by one or more pustules on the surface of the body. The pustule begins by a vesicle surrounded by an inflamed zone, some-

times black, with sero-sanguinolent contents, and filled with free peste bacilli. Certain cases reported by Surgeon-Captain L. F. Child, I.M.S., may perhaps belong to the same category.⁷ Although this eruption has not been recorded frequently in the Indian plague epidemics, yet it may be usefully compared with the pustules caused by nymphs and male ticks, whose habits we may now consider.

The larvae of ticks ascend the stalks and blades of grass, and remain at the summits awaiting the advent of some mammal to which they may transfer themselves. They may often be "observed in the fur of wild rodents; they do not attach themselves by the rostrum."⁸ It is possible that they effect their transformation into nymphae in the ground.⁹ The nymphae live, like the adults, "with the rostrum implanted in the skin of their host—penetrating sometimes beneath it, and causing the formation of purulent tumours. . . . Finally, they leave their host for the ground, where they undergo the change which endows them with sexual organs." The nymphs during this period are nourished on the pus produced in the above-mentioned pustules. Similar pustules are produced by the male tick.

The part attacked by the female tick may suppurate and even form sloughs.⁹ Dr. Theiler also records that the full-grown *H. aegyptium*, known in South Africa as the bont-leg tick, "very often causes a festering wound on the spot of attachment, and even large pieces of skin may become necrotic and drop out."¹⁰

There are, then, two periods in the life-history of the *H. aegyptium* when infection may be conveyed to another animal. The first period is when as a nymph the rostrum is first developed. During this period pustules are caused on the animal attacked. The action of the male tick resembles that of the nymph in this respect.

The second period is when a female tick attacks a mammal in order to withdraw blood. During this period a local slough may be produced in the neighbourhood of the puncture.

In either case the nymph or the tick may be brushed off the host; or may, owing to the death of the host, fall off. In such cases, if a second host is accessible, the nymph or tick will attach itself to it.

Taking into consideration the facts now mentioned, the seasonal incidence of plague in India may thus be explained:

During the rains the young and the ova are, if not concealed beneath stones, washed away by the heavy rain. When the dry season commences the Ixodes betake themselves to bushes, grass, and crops, where they "maintain themselves suspended to plants by their anterior legs, ready to fall upon any animals which pass within their reach."¹¹

Hence the recrudescence of plague when the natives begin to take in their crops. During the "cold" weather the ticks enjoy comparative immunity from rain. When the weather is becoming hot the ticks multiply enormously, this being the normal season for the hatching of the larvae, and during the wheat harvest they leave the corn and grass to attack the native reapers working in their midst. The nymph—and also the male tick—when attaching itself to an animal, inoculates the bacillus; it does this while causing a vesicle, which later becomes a pustule teeming with plague bacilli. The nymph ingests the pus, and when full falls off its host and remains on the soil until developed into the tick. The latter, still carrying the plague bacillus—replenished by those ingested in the pus food of the nymph—attacks and inoculates its host, this time, if a female, without producing a vesicle but causing necrosis at the site of puncture. The female when full falls off, lays her eggs under a stone, and dies. If, however, from some cause she has been removed from her host too early, she attacks the nearest animal in order to complete her feeding and her period of gestation. By this latter method plague might be carried to a man from a mammal of another class.

Domestic rats also suffer most severely at this period of harvest, cornfields¹² having a special attraction for them. The plague incidence commences to fall with the completion of the wheat harvest, owing to the native being less exposed to the ticks in their favourite resting place among the crops and undergrowth; but the number of attacks is still considerable until heavy rain falls and washes the ticks away.

The native with his bare legs is thus peculiarly liable to attack, the well-clothed European being comparatively protected.

The part of the body attacked by the tick determines the site of the earliest bubo. The favourite spot being the scrotum or mammae, explains the point brought out by Dr.

A. M. Elliott¹² that inguinal buboes are most frequent in males, and axillary in females.

When one remembers how minute is the nymph of *H. aegyptium*, one is not surprised that its attack has escaped observation. With regard to the female tick, she is hardly likely to remain any length of time on a human host, for the latter would soon remove any source of irritation, although this would not be done until inoculation had been effected. Consequently she would not be allowed to remain until through distension she had attained dimensions which could not fail to attract attention.

Wheat cargoes, especially when they contain a certain amount of soil among the grain, are liable to contain the young of ticks, which, maturing in the warmth of the hold, may find their way to other animals, and thus cause cases of plague among rats and men. The same may, of course, happen to any cargo to which ticks may have gained access before loading.

With regard to the other factor—a cattle disease—it has already been suggested on page 624 of the BRITISH MEDICAL JOURNAL that we must look to one of the cattle diseases present in India as the source of plague. Ghotwa was noted as present in that country, and of the pasteurellosis this is the one which from its distribution and from the morphology of its bacillus appears to bear the closest relation to plague. It is known generally as barbone, and is the same as buffelseuche in Hungary and khoun-naq in Egypt.¹³

In addition to the above countries, barbone has up to the present been reported as established in Spain and Portugal, Sardinia, Italy, and Tonkin. It remains to be seen whether the epizootics among cattle, which have been noted as occurring during plague epidemics at other places, such as Hong Kong, Manchuria, etc., are also barbone. If this prove to be the case, it will be found that the human plague bacillus is a cultural modification of the barbone bacillus, and both perhaps ultimately cultural modifications of a bacterium ovoid existing under certain conditions of soil.¹⁴ It is possible that the modification may require the passage of the bacillus through the body of the tick. That some such process is required is shown by the difficulty of maintaining the virulence of cultures of the bacteria of haemorrhagic septicaemias, as pointed out by Dr. Yersin,¹⁵ the virulence being reduced by repeated passages through the bodies of experimental animals, as stated by Drs. Kister and P. Schmidt.¹⁶ The latter writers recognize the biological affinity between the plague bacillus and the bacteria of haemorrhagic septicaemias.

There is no exception in the domain of bacteria to the universal law that species adapt themselves to their surroundings. The more complex the organism the longer the time required for adaptation. Conversely, in simpler life forms time may be measured by the duration of life of the individual, and the period required for modification be infinitesimal when measured by the human standard. So that the production of specific changes in an allied group of bacteria may, without damage to established convictions, be conceived to occur during the period of growth of a colony in a medium other than that to which the parent stock had been accustomed. Thus a bacterium ovoid in the soil may become a barbone bacillus in the tissues of a buffalo, and the same bacillus (perhaps only after it has passed through the buffalo) may become a plague bacillus in man, or a rat-plague bacillus in the rat. The conception of such a change is facilitated when the possibility of its being carried out through the medium of the tissues of a tick is realized. This change will, however, only become an accepted fact when its actual occurrence in Nature has been demonstrated.

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OFFICIAL information has been received of the death in Southern Nigeria of Dr. J. F. Stewart. The deceased had only recently returned to the Colony from a visit to his friends in Belfast. He is supposed to have lost his way in the bush and to have been murdered by fanatical natives.

MEMORANDA:

MEDICAL, SURGICAL, OBSTETRICAL, THERAPEUTICAL, PATHOLOGICAL, ETC.

ACUTE OEDEMA OF LIDS AND CONJUNCTIVAE.

THE following case seems worthy of record. I was called on June 28th at 7 p.m. to see a gentleman, aged 28. He had been suffering from hay fever. At 6.45 he had dropped into each eye one drop of pollantin (the new serum for hay fever). In less than two minutes his eyelids commenced to swell, and in ten minutes the swelling was so intense that he had great difficulty in opening them. I found the eyelids enormously swollen, red, and erysipelatous-looking. The conjunctiva was jelly-like and protruding, the iris appearing sunk in and partly covered by it. There was no tenderness over the eyeballs, redness of the conjunctivae or herpetic eruption, and except for the conditions noticed the patient seemed perfectly well. I ascertained that the patient had had three similar attacks before. Two of these attacks occurred in early life from no known cause, the third after bathing the face and eyes with cold water. On each occasion the swelling had appeared in a few minutes and had disappeared again in a few hours.

Cold fomentations were applied, and a solution of cocaine instilled into each eye, and, as I expected, by the next morning the jelly-like effusion had disappeared, leaving a somewhat highly injected conjunctiva. The swelling in the lids had diminished, and twelve hours later were less swollen. The patient's condition had become normal. Shortly after this eye condition the patient complained of tenderness over the testicle, and I discovered enlargements of the veins there. In twelve hours this also disappeared.

The urine contained albumen. It had been examined before and found normal. Thorough examination of the patient's actual condition and late history threw no light on the symptoms mentioned, and showed him to be apparently perfectly healthy.

It is conceivable that the dropsical swelling of the eyelids and conjunctivae, enlargement of the veins beneath the testicle, and albumen in the urine were all dependent on the same cause, giving rise to disturbance of the circulation at these parts. If such were the case one would have expected other symptoms of toxic infection, which were entirely absent in this case. And if there was a tendency to increased coagulability of the blood, it is difficult to understand why the attack was so sudden and what was the cause. That there was a cessation for the time being in the circulatory stream or lymph flow through the lids and conjunctivae there is no doubt; but how this occurred and what was the chief factor in its production are the interesting points in the case. (Pollantin may have done it in this instance, but what did it before?) On one occasion after the marked swelling of the lids, the patient tells me that on the subsidence of the oedema a discoloration remained for a time, at first brownish, and ultimately passing through the phases of green and yellow before finally becoming absorbed. The eyesight remained perfect during the attack.

I can find no record of any similar case, nor can I find any satisfactory description of the mechanism that governs the flow of blood and lymph through the conjunctiva and its neighbouring parts to account for the peculiar condition met with in this case.

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CONDITION OF THE SKIN IN PNEUMONIA.

IN October, 1904, I was called to a young woman, aged 24 years, whom I know to suffer from chronic endocarditis. A week previously she went to a dance, and had not been well since, and during the night before my visit had suffered from "stitch" in the left side. She was thirsty, her tongue clean and moist, temperature 102.7°, pulse 108. Her throat was not sore, but the glands along the anterior border of the left trapezius were enlarged. A little sodium salicylate was given, and next day the pulse was softer, 90 per minute, respirations 24, temperature 99.5°. She slept well and felt better, but subsequent developments led to a consultation being held. Pneumonia of lobar variety (right apical) was diagnosed, and the friends assured that if she lived ten days she would recover. Instead, she slowly worsened for ten weeks, during which time crepitations came and went at all parts of the lung, and finally she died. One of the points I