Transmission and Inoculability of Spirillum Theileri (*Laveran*).

By Dr. A. Theiler.

(Communicated by Colonel David Bruce, R.A.M.C., F.R.S. Received June 28, 1905.)

In 1903 Laveran* described, under the name of *Spirillum Theileri*, a micro-organism which I had found several times in sick cattle. In 1904 I described six cases.† These cases, however, in my opinion did not represent a pure infection of Spirillum, since lesions were present in the red corpuscles, such as basophile granulations, indicating a previous infection with *Piroplasma bigeminum*.

The *rôle* which the Spirillum itself plays as a cause of disease has not as yet been ascertained, but the following notes will help to throw some light on its pathogenic action.

In the communication alluded to above, I described experiments on the inoculation of defibrinated and non-defibrinated blood containing Spirilla from sick into healthy oxen. This experiment failed in eleven animals, although the precaution was taken to utilise, for the most part, imported stock, and the inoculations were made with quantities ranging from five to one hundred cubic centimetres, which were injected subcutaneously, intra-venously, and intra-peritoneally. The injection of blood containing Spirilla into three sheep, two goats, two horses, six rabbits, one guinea-pig, and one rat, also gave negative results. It was then concluded that spirillosis is not inoculable, but this has proved to be a mistake, as further experiments have shown that the disease can be conveyed from sick to healthy animals by the injection of infective blood.

As it has been proved that the Brazilian fowl Spirillum is transmitted by a species of tick, an *Argas*, and since my Spirillum was also found in the blood, the opinion was then expressed, in view of the conclusive evidence of past experiments in tropical piroplasmosis, that cattle spirillosis is also, probably, transmitted by ticks.

The Mode of Conveyance of Spirillosis in Cattle from the Sick to Healthy Animals.—Some observations on bulls on which various kinds of ticks had fed first suggested that this Spirillum might be transmitted by ticks, and, further, that the particular tick in the present case was *Rhipicephalus*

* 'Sur la Spirillose des Bovidés,' par A. Laveran.

† 'Comptes Rendus des Séances de l'Académie des Sciences,' vol. 136, p. 939 (Séance du 20 Avril, 1903).

decoloratus. To prove this inference the following experiments were carried out:—

Six heifers, about the same age, which came from Aliwal North, were stabled on the premises of the laboratory, and successfully infected with *Spirillum Theileri* by a tick. In these experiments the tick (*Rhipicephalus decoloratus*) was fed on the sick cattle during and shortly after the febrile reaction, when the Spirillum was noticed in the blood. Spirilla were found to be present in the blood of the healthy animals in some experiments in 13 days, in others in 17 days, after the infected ticks had fed on them. The above experiments thus prove that the *Spirillum Theileri* is conveyed from the sick to the healthy animals by this tick.

The Effect of Injection of Blood from Cattle Suffering from Spirillosis into Cattle, Sheep, Goats, and Horses.—Oxen and sheep were inoculated with blood containing Spirilla from animals suffering from the disease. Spirilla appeared in their blood after two or three days. It is possible that goats can also be infected by the Spirillum, since a slight febrile reaction after inoculation was observed in two cases, but the Spirillum has not yet been demonstrated in the blood of goats. One horse was injected, but proved refractory to spirillosis. The incubation period of the disease, produced by inoculation of infected blood, is as short as two and three days, whilst after tick infection the duration is 13 to 17 days as above noted.

The development of the blue tick from the larva to the adult takes place on the same host. It is necessary, therefore, that the infection of this spirillosis should pass through the egg stage of the tick. When the egg hatches into a larva, the larva is capable of giving the disease to a healthy animal. As the tick remains on the same host for two or three weeks, it is evident that as an adult it may reinfect itself with Spirillar blood, taken from the same animal it infected as a larva. This is possible on account of the short incubation period of the disease. None of the animals died from spirillosis. Enumeration of the red blood corpuscles shows that the Spirillum produces slight anæmia, not sufficient, however, to cause death. Some of the animals went off their feed, and a loss of condition was noticeable.

The Blood of an Ox which has Recovered from Spirillosis is Infective and Blue Ticks fed on such an Animal can acquire the Infection and Transmit it to Healthy Animals.—Five sheep were injected intravenously with defibrinated blood of an immune ox and contracted spirillosis. By an immune ox I mean an animal which has recovered from an attack of spirillosis and is no longer susceptible to the disease. Thus the blood of the healthy immune ox is infective, although it is impossible to determine the presence of the parasite microscopically.

Summary of Conclusions.

1. The *Spirillum Theileri* is naturally transmitted by the progeny of *Rhipicephalus decoloratus* which have developed on cattle suffering from or recovered from Spirillum infection.

2. It is possible to produce spirillosis-susceptible cattle and sheep by the injection of blood from sick or immune animals. The proof that the blood of immune sheep is infective is yet wanting.

3. The pathogenic effect of Spirillum is a slight anæmia accompanied by fever. In none of my cases did a fatal result occur.

An Experimental Enquiry into the Nature of the Substance in Serum which influences Phagocytosis.

By George Dean, M.A., C.M., M.B., Bacteriologist-in-Charge of the Serum Department of the Lister Institute of Preventive Medicine, London.

(Communicated by Professor J. Rose Bradford, F.R.S. Received July 8, 1905.)

Metchnikoff, and his school, in the face of much opposition, lasting many years, have offered convincing proofs of the importance of phagocytosis in the protection of the animal body against bacterial invasion. The main theses of the Metchnikovian theory are now almost universally accepted, but the exact mechanism of the processes involved is even now the subject of keen controversy. If a highly virulent organism is injected into a susceptible animal, the leucocytes appear to be repelled, and to be unable to deal with the microbe, which multiplies and causes the death of the animal. If, however, the suitable immune serum is injected into the animal before inoculation, the phagocytes attack and devour the invading micro-organisms.

Much discussion has centred round the interpretation of such experiments. The early work of Nuttall and others on the bactericidal action of normal serum, and Pfeiffer's demonstration of the bacteriolysis of cholera and typhoid bacilli by immune sera in the absence of cells, formed the chief basis on which rested the humoral theory, which attributed the protection in such cases to the destructive action of the serum on the microbes. Flügge graphically illustrated the view of the humoralists by likening the phagocytes to the trenches made ready behind the fighting line to receive the conquered dead.