having selected a spot of the rash somewhere on the trunk and thoroughly cleansed the site with absolute alcohol, blood expressed after puncture with a needle has in numerous instances been found to contain both spirochæta pallida and spirochæta refringens. Other observers who have seen our specimens have confirmed the presence of both forms. No contamination was possible in these cases as the glass slide on which the film was made touched the drop of exuding blood only and never came in contact with the epithelium. Furthermore, the cleansing with absolute alcohol was most carefully carried out. We saw no other organisms or foreign matter in these films, and a search of from one to two hours was frequently necessary. Furthermore, if a spot of the rash be similarly sterilised and a blister raised over it by means of strong ammonia the fluid in the blister will be found to contain numerous spirochætæ pallidæ and up to the present we have seen no spirochæta refringens in this fluid. We have not as yet found the organism in blood films taken from the same patient's finger. The ulcerated throat of the secondary stage, also mucous patches and ulcerations on the lips and commissures of the mouth, show all forms of the organism. Puncture with a hypodermic needle of the tonsil, when enlarged and not necessarily ulcerated, furnishes beautiful specimens of the spirochæta refringens and spirochæta pallida in their finest forms. We have not found it in any of the following tertiary lesions, ulcer of the leg, gumma of the tongue, tertiary ulceration of the hard palate, and late secondary rupial rash; nor have we found any spirochætæ in gonorrhœal warts and non-syphilitic chancres. In the smegma we have seen thread-like organism sometimes of branching and wavy form but very easily distinguished from spirochæta pallida and spirochæta refringens.

4. *Culture.*—All our attempts to grow the organism in broth, agar, or blood serum from blood of patients in which we had previously found the organism have failed.

5. *Theory.*—Our idea is that the spirochæta pallida is the real specific organism of syphilis. That the organisms we have described as spirochæta refringens are polymorphic forms of the same organism. That the spirochæta pallida as we have found it by our constant study of it in all situations in which it has been found tends to be limited to the deeper parts and the internal organs. That the spirochæta refringens occurs only on the surface where the disease is manifested by its external lesions. It is possible that the spirochæta pallida circulates freely in the blood and that as it develops it becomes spirochæta refringens, that this larger organism forms emboli in the capillary circulation, and at the site of these emboli the external lesions of the disease are produced, and the organism undergoes further development for the spread of the disease. In the *Medical Chronicle* for February, 1906, one of us (G. M. O. R.) in recording a number of cases thinks that spirochæta pallida in the primary lesion is diagnostic of syphilis. We should like to add that we have never yet seen spirochæta pallida in the primary lesion without seeing many more refringens and that we regard this organism as diagnostic of spirochæta pallida.

OBSERVATIONS ON THE ANIMAL REACTIONS OF THE SPIROCHÆTA OF THE AFRICAN TICK FEVER.

BY A. BREINL, M.D.,
ASSISTANT LECTURER AND GARRETT INTERNATIONAL FELLOW;
AND
A. KINGHORN, M.B.,
COLONIAL FELLOW, LIVERPOOL SCHOOL OF TROPICAL MEDICINE, UNIVERSITY OF LIVERPOOL.

A Preliminary Note.

THE strain of spirochætæ used for the following experiments was that discovered by Dr. J. E. Dutton and Dr. J. L. Todd in cases of human tick fever occurring in the Eastern part of the Congo Free State and brought to England by Dr. Todd in the infected monkeys and ticks. Their observations are published in one of the memoirs[1] of the Liverpool School of Tropical Medicine. From one of the monkeys infected by ticks which died showing numerous spirochætæ in the blood sub-inoculations were made intraperitoneally into three rats, two receiving five cubic centimetres and one seven cubic centimetres (Experiment 985). The smallest of the rats, about one and a half months old, showed spirochætæ in the blood at the time of the first examination some 14 hours a ter inoculation. The number of spirochætæ increased rapidly until, at the time of the rat's death, which occurred suddenly five hours later, the corpuscles were entirely obscured by the innumerable parasites present in the blood. In the case of the other two rats (both full grown) parasites were present in the blood in small numbers 12 hours after inoculation (one to one to three fields: Zeiss oil immersion $\frac{1}{12}$, ocular 4) and were found continuously in large numbers until the rats died, one (985 B) after four days and the other (985 A) after seven days. Sub-inoculations from 985 B were made into two rats, Experiment 990, A getting two cubic centimetres and B one cubic centimetre of blood intraperitoneally. The spirochætæ were found at the time of the first examination (16 hours after inoculation) in large numbers and increased for four days when both rats died, showing innumerable parasites.

Further sub-inoculations from this have been made and show that the incubation period varies between two and six hours in the rat if blood containing numerous spirochætæ be used for the inoculations. The incubation period, however, may be prolonged, as is shown in one case, to nine days or even as long as 21 days in another case. The blood used for this inoculation was derived directly from a monkey infected by means of the bites of infected ticks and which had had a short attack, the spirochætæ being at first present only in small numbers and afterwards absent for two weeks and finally very scarce (one to a preparation) just before death.

The duration of the disease in rats varied between one and 45 days and was increased by the passage of the spirochætæ through several rats. A noticeable feature in those rats in which the disease ran a longer course was the gradual increase in the number of parasites for a few days until in many cases they were uncountable, followed by a corresponding decrease in number to complete disappearance. After a short period of absence the spirochætæ again reappeared and the cycle was repeated three or four times before the animal died, but during the "relapses" the number of parasites never rose so high as in the first attack.

From the pathologico-anatomical point of view the most striking feature was a more or less pronounced enlargement of the spleen (sometimes thrice the normal size). Very frequently this organ contained hæmorrhagic infarcts of varying size, in some cases involving half the spleen. Often the process had proceeded further and small anæmic infarcts were found. The Malpighian bodies were enlarged and greyish in colour. The trabecular system was not pronounced. The liver usually was enlarged and showed hæmorrhages under the capsule and in its substance. Small necrotic areas were found scattered through the liver substance. The bone marrow was very soft and of a pale greyish colour. Petechiæ in the serous membranes were frequent.

Six mice were inoculated intraperitoneally with from 0·2 to 0·5 cubic centimetre of citrated blood containing many spirochætæ. All showed the parasites in the peripheral circulation the following day. Four died during the course of this day showing from one to six spirochætæ per field; two died after 48 hours with numerous parasites in their blood. At the post-mortem examination the spleen was found to be much enlarged in every case.

Six rabbits were inoculated intraperitoneally with large amounts of heavily infected citrated blood (from 10 to 20 cubic centimetres) from monkeys and rats. The animals usually showed parasites in the peripheral blood within from two to three hours afterwards; the number of these increased, as a rule, for the first day and a half (in one case the spirochætæ were so numerous that they could not be counted), then decreased until, after three days, the blood examinations were negative. The temperature of the rabbits rose from 100°–101° to 104°–105° F. within about six hours and fluctuated between 105° and 106·6° until the death of the animals, which occurred in from three to ten days. Marked symptoms of malaise were noticeable shortly after the inoculation and continued until death. Sub-inoculations into rats were positive only in the case of one rabbit

[1] Dutton and Todd: The Nature of Human Tick Fever in the Eastern Part of the Congo Free State, Memoir XVII., Liverpool School of Tropical Medicine, Liverpool, 1905.

which died the third day after inoculation. The post-mortem findings were similar to those found in the rats but usually more marked in severity. The spleen was enlarged and showed hæmorrhagic and anæmic infarcts, the liver showed necrosis, and the bone marrow was very soft, and scattered through the reddish marrow were numerous greyish areas.

Four guinea-pigs were inoculated, also intraperitoneally. Two, inoculated with 15 cubic centimetres of blood showing from 20 to 30 spirochætæ per field, showed parasites in small numbers the following day (1 to 40 fields) and died on the third day showing in the heart blood from one to ten spirochætæ in each microscopical field. The temperature showed a marked rise, reaching 104°. Two, inoculated with five cubic centimetres of infected blood, showed parasites in the peripheral circulation two hours later. The spirochætæ increased in number until the next evening, when from one to two per field were seen and then decreased. After the third day the blood examinations were negative. The temperature fell to normal and both are still alive (one 36 days and the other 27 days after inoculation). In the guinea-pigs which died slight enlargement of the spleen was the only visible finding.

One dog (nine months old, mongrel), Experiment 1018, was inoculated intraperitoneally with 15 cubic centimetres of citrated blood showing numerous spirochætæ. Two hours later parasites were found in the peripheral circulation; they increased in number till the next evening when there were from five to eight in one field of the stained specimen and then decreased. On the fourth day no parasites were found and the blood has since remained free from spirochætæ. Sub-inoculations into rats proved negative. Within six hours of the inoculation the temperature rose from 100° to 103·2° and after the third day fell to normal with no subsequent rise.

One pony, Experiment 1019, was inoculated intraperitoneally on Jan. 16th with 17 cubic centimetres of pure heart's blood from a rat showing from five to 20 spirochætæ per field. Seven hours later four spirochætæ were seen in one-half of the film specimen of blood. At the same time the number of leucocytes was increased. The parasites increased in number during the next day until, in the evening, from one spirochæta in two fields to from one to 25 parasites per field were seen. They were still present on the third day but on the fourth day had disappeared and have remained absent since. Corresponding to the appearance of the spirochætæ the temperature rose from 98·6° to 103°, maintained that level for three days, and fell on the fifth day to 99 8°. No rise of temperature has been observed since.

One monkey, an adult Cercopithecus, was inoculated subcutaneously with one cubic centimetre of blood (from 60 to 80 spirochætæ per field). Parasites in small numbers were seen in the blood 24 hours later. A corresponding rise of temperature was noticed. The spirochætæ increased in number and disappeared after three days. At certain intervals the parasites were seen in the peripheral blood, being present for a few days and then disappearing again.

Monkeys showed blood infection after an incubation period of five days after the bites of infected ticks. In monkeys which died from the infection the spleen and liver were found to be the most markedly changed. The spleen was considerably enlarged and contained anæmic infarcts of varying size and extent corresponding to the duration of the disease. In some cases the spleen substance contained very numerous small necrotic areas about a millimetre in diameter. The liver contained hæmorrhagic areas and small necroses. The bone marrow was soft and greyish-red in colour.

From the above experiments it is apparent that we have been able to infect with the spirochæta of African tick fever in addition to monkeys, a horse, a dog, rabbits, guinea-pigs, rats, and mice. The rabbits, rats, mice, and some of the guinea-pigs have succumbed to the infection. Previous observers have not been able, so far as is known up to the present, to infect any animal other than monkeys with the spirochæta Obermeieri. These experiments lead to the conclusion that the spirochæta of the African tick fever differs from the Spirochæta Obermeieri. While the animal reactions are different from those of the Spirochæta Obermeieri, the pathological anatomical lesions are the same as those described in human beings who have succumbed to the infection by Spirochæta Obermeieri.

THE PRESENCE OF THE SPIROCHÆTA PALLIDA IN SYPHILITIC LESIONS.

BY LEONARD S. DUDGEON, M.R.C.P. LOND.,
BACTERIOLOGIST TO ST. THOMAS'S HOSPITAL AND JOINT LECTURER ON GENERAL PATHOLOGY IN THE MEDICAL SCHOOL.

As it is still a debateable point whether the spirochæta pallida is a direct cause of syphilis, I thought it advisable to record briefly the following observations made upon cases of primary, secondary, tertiary, and congenital syphilis. In every case the surface of the syphilitic lesion was carefully cleansed and then firm pressure was applied for a short space of time until a small quantity of serum was evacuated. Film preparations which were made from this fluid were stained by my modification of Leishman's stain as published in THE LANCET of August 19th, 1905, p. 522. The spirochætæ by this method stand out quite clearly and definitely and are stained a faint purple colour.

The following is a list of the cases examined by me from July, 1905, until the present time:—

CASE 1.—A child suffering from congenital syphilis. Condylomata were present around the anus. Large numbers of the spirochæta pallida were found to be present.

CASE 2.—A male, aged 30 years, suffering from secondary syphilis. The spirochæta pallida was found to be numerous in film preparations made from the mucous papules in the mouth.

CASE 3.—A female, aged 25 years, suffering from a gummatous ulcer situated on the front of the leg. Film preparations were made from the surface of the ulcer but no spirochætæ were found.

CASE 4.—A male, aged 30 years, suffering from a primary chancre on the glans penis. Typical examples of the spirochæta pallida were obtained from the chancre.

CASE 5.—A female, aged 21 years, suffering from general secondary syphilis. No spirochætæ were obtained either from the skin eruptions or from two cubic centimetres of blood withdrawn from the patient's thumb into a sterile solution of citrate of soda.

CASE 6.—A male, aged 25 years, suffering from a primary chancre on the glans penis. The spirochæta pallida was present in films made from the chancre.

CASE 7.—A female, aged 40 years, suffering from a syphilitic eruption on the face. No spirochætæ were obtained.

CASE 8.—A female, aged 20 years, with a gummatous ulcer on the leg. No spirochætæ were seen.

CASE 9.—A child, aged one year and four months, suffering from condylomata around the anus. Numerous spirochætæ were found to be present.

CASE 10.—A child, aged one year and two months, suffering from congenital syphilis. Large numbers of the spirochæta pallida were obtained from the condylomata around the anus.

CASE 11.—A male, aged 32 years, suffering from a primary chancre on the penis. No spirochætæ were seen.

CASE 12.—A male, aged 40 years, with a gummatous ulcer on the ankle. No spirochætæ were observed.

CASE 13.—A female, suffering from a large suppurating swelling on the left side of the mouth which was incised and from the interior large numbers of the spirochæta pallida were found to be present. This swelling was found to be a *gumma*. The patient also had other evidence of *tertiary syphilis*.

CASE 14.—A child, aged four years, suffering from a primary chancre on the lip. The spirochæta pallida was found to be present.

CASE 15.—A female, aged 30 years, suffering from a softened gumma of the arm. Three cubic centimetres of fluid were withdrawn from the interior of the mass and centrifugalised. Film preparations were made from the deposit but no spirochætæ were found.

CASE 16.—A male, aged 32 years, suffering from secondary syphilis. Numerous spirochætæ, which resembled the spirochæta pallida, were obtained from mucous patches around the mouth and also the spirochæte of Vincent.

CASE 17.—A female, aged 30 years, suffering from a gummatous ulcer of the leg. No spirochætæ were found.

CASE 18.—A male, aged 18 years, suffering from a small