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SOME NOTES ON THE MORPHOLOGY OF *SPIROCHÆTA DUTTONI* IN THE ORGANS OF RATS

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The strain of *Spirochæta duttoni*, brought from the Congo by Dutton and Todd, is maintained in the Runcorn Research Laboratories through inoculation of infected blood from rat to rat. By Levaditi's¹ silver method I have investigated the morphology of the parasites in the organs of some of these animals killed at different stages of the infection.

The principle of the silver method may be briefly stated as follows:—The organs, after fixation in formol, are impregnated with a solution of silver nitrate, and then exposed to the reducing action of pyrogallie acid. In thin paraffin sections the tissues appear of a bright yellow colour, with sufficient differentiation of the nuclei; the spirochaetes black, with sharply defined outlines. To bring out the relation of the parasites to the tissues, Giemsa's or other stain may be employed.

The pyridin-silver modification, the 'second method' of Levaditi, gave generally good results, not only with fresh material, but also in organs which had been kept for some months in formol.

Details of the course of experimental spirochaete-infection in rats may be found in the extended study of Breinl and Kinghorn;² here it is only necessary to repeat that the maximum number of parasites in the peripheral circulation is reached on about the fifth day after inoculation, after which the spirochaetes disappear rapidly and completely, until the first relapse, which occurs in about a week and extends over one to three days.

Examination of sections (4 to 6 μ) of the organs of rats, killed at the height of the infection, shows the large and small blood-vessels and capillaries crowded with spirochaetes, in accordance with the observations of Levaditi.

The outlines of the parasites are best seen in the capillaries of the lung and liver, whereas in sections of the heart and large blood-vessels the spirochaetes are generally found massed in broad strands. In the spleen at this stage a different condition is observed; the parasites being comparatively few in number, and mostly intracellular.

The shape of the spirochaetes is not everywhere the same; characteristic organisms, showing regular spirals, being generally seen in lung and heart; while the liver and the spleen contain atypical forms, which can be recognised only by their staining reaction, and by the conditions under which they are found and by the presence of intermediate stages. These forms are seen as small, circular or oval, tightly-coiled spirals, about half the size of a red blood-cell.

Similar forms have been described and figured by Breinl and Kinghorn. These authors found "occasionally in films made from the liver and the spleen spirochaetes coiled up into a small compass, staining a deep red with Giemsa's stain, and surrounded by a well-stained membrane." Levaditi has also observed them as occurring in the liver of mice, and discusses their probable nature in the light of similar appearances met with by himself, Manouélian, Cantazucène, v. Prowazek,³ Schaudinn, and other authors, in the spirillosis of fowls. He interprets them as agony-forms, preceding further stages of degeneration and disintegration. v. Prowazek, on the contrary, considers these bodies as "resting stages" in the life cycle of the parasite.

With regard to this interesting question, I may state that these forms occur in by far the greatest numbers in the liver, less numerous in the spleen, scantily in the lung, while in sections of the heart-blood they could not be demonstrated with certainty.

Moreover, very few, if any, have been observed free in the lumen of the capillaries, the majority being easily demonstrated in phagocytes.

These two facts—the excessive disproportion in the number of these altered forms found in the liver, and their approximately constant relation to phagocytes—seem to afford a strong argument in favour of Levaditi's hypothesis.

Observations were also made at the crisis of the disease. Breinl and Kinghorn have already pointed out the difficulty of determining this period. In one case described by these authors, the disappearance

of the parasites from the peripheral circulation occurred between 2 and 5-30 a.m.

In the present case, material at this period was obtained with less difficulty. A rat (1,540 B) inoculated on July 20, 1907, showed very numerous parasites in thick films of tail-blood on the morning of July 25. It was examined five hours later, when the parasites were found to have disappeared almost entirely from the peripheral circulation; the animal was then killed for the purpose of examining the organs at the stage of crisis.

Very few spirochaetes were observed in the vessels and capillaries of lung and kidney. The spleen showed a moderate number of large phagocytes containing partly digested and fragmented spirochaetes. In the liver, on the contrary, the capillaries were crowded with parasites, or, to be more exact, were nearly or quite occluded by swollen mononuclear phagocytes—endothelial cells and cells of Kupfer—filled with innumerable black granules, many coiled forms and only a few normal spirochaetes.

This observation seems to lend additional support to the hypothesis that the coiled forms are due to the influence of phagocytosis. At the height of the infection the vessels of the different organs were crowded with free, apparently unaltered spirochaetes, and the liver showed in addition a great number of intracellular coiled forms; at the crisis the extracellular parasites had disappeared almost entirely, and in the liver were found, besides the cell-included coiled forms, large numbers of fragmented parasites and granules, evidently products of intracellular digestion.

The occlusion of many of the capillaries of the liver by swollen phagocytes seems to account for the hemorrhagic and anaemic infarcts observed by Breinl and Kinghorn. Levaditi is also inclined to explain the changes observed by him in the liver of infected mice, by obstruction of the blood-vessels of this organ.

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