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MORPHOLOGICAL AND PATHOGENIC VARIATIONS
IN TREPONEMA PALLIDUM.*

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PLATE 29.

Now that *Treponema pallidum* can be cultivated artificially, it becomes readily possible to consider the question of differences in strain among the species that may amount to racial variations. Many observers have doubtless noted differences in the morphology of the pallida in living and dead film preparations and possibly even in stained tissue specimens. It would scarcely be possible to divide the species into strains on the basis of such superficial characters; but now that artificial cultivation has been accomplished, the question can be approached with adequate means for its solution.

During 1910 and 1911, while carrying simultaneously ten different strains of the pallidum through the testicles of rabbits for many generations, I was struck with the fact that certain strains appeared thicker than others. Most of the pallidum strains in my collection showed the thickness, length, and curves ordinarily recognized for this organism (figure A). On the other hand, two of the ten strains were distinctly thicker (about 0.3 of a micron), and one was thinner (about 0.2 of a micron) than the average (about 0.25 of a micron). The curves of the heavier type were quite typical (figure B), while those of the thinner strain were somewhat shallower and set more closely, except the portions towards the extremities, which were again quite typical (figure C). These characteristics were retained unmodified throughout the numerous transfers from one rabbit to another within a period of over a year. Further, it was noted that the thinner strains possessed greater agility than the heavier ones.

As regards the production of testicular lesions in the rabbit, the

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different types of the pallidum showed different effects. Seven strains of typical morphology produced a diffuse induration and swelling, usually within three weeks, that progressed steadily for five or six weeks, when spontaneous retrogression set in. The thicker type, including two strains originally transmitted to rabbits from cases of protracted chancres on the lip and prepuce, respectively, did not, as a rule, produce any change in the inoculated testicles until about five or six weeks after inoculation, when small, localized, hard nodules developed. The nodules continued to increase in size slowly and remained sharply demarcated from the surrounding soft tissue, attaining their maximum size in eight to ten weeks. Unlike the effects caused by the typical strains, the nodules produced by the heavier ones were cartilaginous in consistence and contained a greater quantity of mucin. The thinner strain that was transmitted originally from a mucous patch in a case of malignant syphilis, always caused diffuse testicular swelling, within ten to fourteen days, that progressed rapidly for five to six weeks.

Of these three forms of the pallidum, namely, thicker, average, and thinner types, I have succeeded in cultivating from the testicle of the rabbit one specimen of the thinner, five of the average, but none of the thicker variety. The pure cultures of both types were found to produce typical syphilitic orchitis in the rabbit.¹

During 1911, I have cultivated six strains of the pallidum directly from human syphilitic lesions including chancres, condylomata, and skin papules.² I wish now to report briefly upon certain morphological differences that I have observed in different cultures of the pallidum obtained directly from human sources.

Of the six strains cultivated directly from human cases, three exhibit the perfectly typical morphology, while one is thicker and two are thinner than the average. The average or typical strains all came from chancres, the thicker one from a chancre, and the thinner strains were respectively from a condyloma and a chancre in which they were associated with a regular strain.

Under cultural conditions, every pallidum strain is subject to some degree of morphological change through which very long filaments, seldom seen in syphilitic tissues, with shallower or compara-

¹ Noguchi, *Jour. Exper. Med.*, 1911, xiv, 99.

² Noguchi, *Jour. Exper. Med.*, 1911, xv, 90.

tively few curves, appear. But, when provided with optimum conditions, the morphology approaches the normal to such an extent that no difference can be found between the cultivated and the natural pallidum occurring in the tissues. When, however, comparison of the three main types of the pallidum is made under optimum cultural conditions, the definite variations are easily observed. Even under less favorable cultural conditions, in which some irregular forms are apt to appear, the type characteristics between the thinner and the two thicker forms can still be clearly made out. Under distinctly unfavorable conditions, the differences between the thicker and the regular types becomes less evident.

In spite of the morphological variations mentioned, all the strains grow, under common conditions, with identical macroscopic appearances. Further, they are all pathogenic for certain species of monkeys.

In morphology, the thinner pallidum presents marked resemblance to *Treponema microdentium*,³ especially when the microdentium has been under cultivation for two or three weeks; but in macroscopical characters of growth, in respect to non-requirement of fresh tissue for multiplication, and, especially in the occurrence in old cultures of a characteristic fetid odor, the microdentium is sufficiently differentiated from this strain of the pallidum.

SUMMARY.

When many cultures of *Treponema pallidum*, whether obtained from the testicular lesions produced in rabbits or directly from human cases of syphilis, are compared, certain definite differences in morphological character become apparent. The different specimens can be divided into thicker and thinner forms or types, and an average or normal form or type. The last is the common or most frequent variety, but the other two occur with sufficient frequency and retain their characters with such constancy as to constitute distinct varieties. Indeed, two of the varieties—the average and the thinner—occurred in association in a chancre and were separated afterwards in cultures. The gross cultural properties of the three varieties present no points of distinction.

³ Noguchi, *Jour. Exper. Med.*, 1911, xv, 81.

The lesions caused in the testicle of the rabbit differ according to the variety inoculated, and consist either of a diffuse or of a nodular orchitis. This is a highly important distinction, and if, in the study of a still larger number of specimens of pallida, it is maintained, it is capable of throwing light on certain important clinical features of the human syphilitic disease.

The thinner variety of *Treponema pallidum* resembles in morphology *Treponema microdentium*, from which it is unmistakably distinguished by cultural characters.

The morphological and pathogenic variations in cultures of the pallidum may constitute racial differences within the species.

EXPLANATION OF PLATE 29.

FIG. A. Regular type of *Treponema pallidum*. Schematic reproduction.

FIG. B. Heavier type of *Treponema pallidum*. Schematic reproduction.

FIG. C. Thinner type of *Treponema pallidum*. Schematic reproduction.

FIG. D. Various forms of the thinner pallidum in a pure culture. Schematic reproduction.

FIGS. 1 and 2. A long form of the regular type of the pallidum. From a pure culture thirty-two days old. $\times 1,400$.

FIG. 3. Average forms of the regular type in a pure culture two weeks old. $\times 1,400$.

FIG. 4. Agglomeration of the pallidum of the regular type. From a pure culture four weeks old. $\times 1,400$.

FIG. 5. A pallidum of the thinner type. From a pure culture three weeks old. $\times 1,400$.

FIG. 6. A pallidum of the thinner type. From a pure culture three weeks old. $\times 1,400$.

FIG. 7. A pallidum of the thinner type showing deeper curves near one end. $\times 1,400$.

FIG. 8. A group of pallida from a pure culture of the thinner type. $\times 1,400$.

FIGS. 9 and 10. Masses of entangled pallida from two different pure cultures of the thinner type. $\times 1,400$.

