

Clinical and Other Notes.

THE ANNULAR FORMS OF *SPIRONEMA PERSICA*.

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THE occurrence of relapsing fever among troops in Cyprus has established that tick-borne relapsing fever is endemic on the island [1]. The spironema was found in the blood of troops usually about nine days after bivouacking in caves infested by the tick *Ornithodoros tholozani*. Doubtless cases had previously occurred among the civil population on the island as it was generally believed in rural areas that bouts of fever followed the bites of ticks.¹ The causative organism of this Cyprian relapsing fever has been conveyed to guinea-pigs [2] and is thus almost certainly *Spirochaeta persica* which is also responsible for the tick-borne relapsing fever of other Levantine countries.

The morphology of the organism was studied [2] by the method of suspending heavily infected guinea-pig blood in human citrated serum. By this means the guinea-pig corpuscles are agglutinated and the spironema is observed by dark-field illumination free in clear serum apart from the agglutinated corpuscles. In serum preparations ringed with vaseline the spironema remains alive and actively motile for more than two days. The spironema is a regularly coiled spirochaete and possesses from three to eleven coils. Under dark-field illumination it has a dark central spiral core bounded by brightly illuminated walls. Fine spiral filaments, one at either end of the organism, can often be seen. Sometimes two organisms are joined end to end by a fine single spiral filament. Annular forms, in which the ends of the organism are joined together by a fine filament to form a continuous circle, were also observed in these preparations of the Cyprian spironema. The annular forms are highly motile rotating to and fro for many hours. The present communication describes the structure of the annular forms in greater detail.

Obermeier described coiled and circular forms of *Spirochaeta recurrentis* when he first discovered the causal organism of relapsing fever in the Berlin epidemic of 1867. Little attention has, however, since been given to the nature of these coiled and ring forms, though many observers must have encountered coiled forms in routine clinical examination of fixed films from cases of relapsing fever and Noguchi has described degenerate spherical forms of the organism in old cultures.

The annular forms of *Spirochaeta persica*, when examined under dark-field illumination with the technique described above, are seen to consist of a motile free inner spironema revolving inside a tubular ectoplasmic sheath. It has long been suggested that the *Spirochaetales* possess an ectoplasmic covering and that the spiral filaments attached at either end of the ordinary free form are really prolongations of the ectoplasmic envelope. The formation of these annular forms permits this ectoplasmic covering clearly to be seen apart from the contained endoplasm. On the adoption of ring formation the outer circumference of the

¹We are indebted to Mr. Theophilus Mogabgab, Curator of Antiquities, Famagusta, for this information.

sheath is stretched into a circular shape, while the inner side of the envelope is thrown into loose folds, both being clearly visible apart from the inner motile endoplasm. The outer circumference of the ectoplasmic (or capsular) sheath is seen as a fine brightly-illuminated filamentous covering encompassing the inner snake-like spironema and is most readily visible opposite the troughs in the wave structure of the inner spironema. Here the sheath is stretched across between the crests in the sinuosities and is momentarily not in contact with the inner motile endoplasm. Over the actual crests of the wave the superficial envelope is not visible as it is here in contact with the inner motile substance. This part of the envelope (over the actual crests of the wave) soon, in its turn, becomes visible as the crests are replaced by troughs. The inner circumference of the ectoplasmic covering of the annular forms is also seen as a fine filamentous structure on careful scrutiny. It is, however, much looser than the outer ectoplasm and is readily thrown into folds to which wave motion may be imparted by the contained motile endoplasm. Between the two ends of the spiral endoplasm the ectoplasm is seen as a single bright thread preserving the continuity of the circle. The ectoplasmic sheath is extremely fine and careful focusing and light adjustment are necessary to delineate both its inner and outer circumference. For this purpose an iris diaphragm in the body of the 1/12 objective is almost an essential so that the diameter of the stop can be varied at will.

ANNULAR FORM OF *Spironema persica*.

The mode of formation of the annular forms remains a matter of conjecture. Annular forms have, however, been observed being produced by the entanglement of the opposite ends of the same free spironema. The ectoplasm of the terminal filaments presumably becomes continuous and an ectoplasmic tubular sheath results in which the imprisoned endoplasm continues to rotate. The outer circumference of the tubular sheath is stretched out of its spiral shape and is thus in part separated from the endoplasm. The inner circumference is, on the other hand, loose and is readily thrown into folds. The adoption of the annular structure has enabled the previously tightly attached ectoplasmic envelope to be seen in part clearly separated from the contained endoplasm. In one instance at least two short 4-coiled spironemata were observed inside one and the same capsular sheath, and also many short 3- and 4-coiled organisms have been seen in the vicinity of groups of the annular forms. These facts raise the possibility that the sheaths of the annular forms can be discarded. Discard of the original ectoplasmic covering of the spironema might well account for the well-known change in serological character of the organism as isolated from successive relapses of the disease, loss of original ectoplasm being associated with change in antigenic structure.

SUMMARY.

The annular forms of *Spironema persica* consist of motile endoplasm rotating inside an ectoplasmic envelope. The adoption of the annular structure allows the ectoplasm covering of the spironema clearly to be demarcated from its endoplasmic contents.

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REFERENCES.

- [1] WOOD, R. C., and DIXON, K. C. (in the press).
- [2] DIXON, K. C. (1943). *J. Royal Army Medical Corps.*