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During the last few years various investigators have been intensively studying the ultrastructure of the endogenous developmental stages of coccidia of the sub-order Eimeriidae (Mosevich and Kheysin, 1961; Kheysin, 1965a, 1965b; Kheysin and Snigirevskaya, 1965; Scholtyseck, 1965a, 1965b; Sheffield and Hammond, 1965; Scholtyseck et al., 1966).

It has been observed that various species have merozoites with special ultrastructures which furnish a means of penetrating into the host cell. These include the conoid, the toxonemes, the paired organelles and the peripheral tubular fibrilles. The last are apparently contractile elements. The characteristic serpentine movement of the merozoites and the bending of their bodies probably depends on the contraction of these fibrilles. Not long ago merozoites were seen to have a special organelle, the micropore, which fulfills the function of a cytostome (Kheysin, 1965a; Kheysin and Snigirevskaya, 1965; Snigirevskaya, 1967). During studies of the microgamonts of several species of Eimeria the structure of the microgametes was learned and several principles by which the basal bodies and flagella of the developing microgametes are formed were discovered (Kheysin, 1965b). At this time the opinion was expressed that the basal bodies of the flagella of the microgametes form de novo in the growing microgametocyte. Neither basal bodies nor the centrioles which are homologous to them were discovered in the merozoites of E. intestinalis, which turn into microgamonts. These organelles have not been observed in the merozoites of E. perforans, E. stiedae (Scholtyseck, 1965a) or E. bovis (Sheffield and Hammond, 1965).

In the meantime, continuing our electron microscope studies of merozoites of Eimeria intestinalis from rabbits, we found in them some ultrastructures which have a definite resemblance to centrioles. They are described below.

The methods of the electron microscope study were standard. On the seventh day after infection pieces of rabbit small intestine (infected with adult 2nd-generation schizonts of E. intestinalis) were fixed in 2% OsO_4 and embedded in araldite. Ultra-thin sections were "stained" with uranilacetate and lead oxide. The study was conducted with the JEM-5G electron microscope.

During this work we examined a multitude of photographs of longitudinal and transverse sections of the merozoites. Several hundred merozoites were studied in detail with the aid of the electron microscope. In only 10 merozoites did we see the characteristic ultrastructures which had never before been seen at this stage of development.

Anterior to the nucleus and immediately adjacent to it nine ringlets with solid walls and a clear center were found. These ringlets formed a circle like those of flagella, cilia or centrioles. The diameter of this circle was about 1700 Å, while the clear center had a diameter of 150 Å. In the middle of the circle bounded by the nine ringlets was a clearly visible central ringlet of the same structure and diameter as the peripheral ones (Figs. 1-3). Around this central ringlet was a bright zone, separated from the darker surface zone by an interrupted filament about 20 Å thick. It may be that the nine peripheral ringlets and the single central one were a transverse section of the tubular fibrilles. In one section we saw these tubular fibrilles in longitudinal section. Their length was about 2,000 Å. Thus, it may be considered that the nine peripheral tubular fibrilles form the wall of a short cylinder, in the center of which there is yet another short tubule.

This structure is similar to a certain degree to the cellular centriole, and we shall hereafter refer to it as such.

The position of this centriole is in all cases identical. Its longitudinal axis lies perpendicular to the longitudinal axis of the merozoite's body. In all longitudinal sections of the merzoite the centriole is visible in transverse section. In one merozoite we could see two centrioles which lay parallel to each other next to the nucleus. In forming merozoites the centriole is situated not far from the anterior end between the nucleus and the conoid (Fig. 3). In completely formed merozoites the centriole is always situated next to the nucleus and in front of it.

In referring to this structure as the centriole, we must make clear that it differs from typical animal cell centrioles and from basal bodies. The centriole represents a cylinder, the wall of which consists of nine groups of peripheral tubules (or tubular fibrilles). The number of tubules in each group varies from one to three. The central tubular fibrille in the centrioles or basal bodies is absent (Gall, 1961; Gibbons and Grimstone, 1960). Only in the basal bodies of Euplotes has entrance of the central pair of tubular fibrilles from the body of the cilia been observed (Roth, 1956).

According to Scholtyseck (1956b) and my own data (Kheysin, 1965), the basal body of the flagella of the microgametes of E. perforans and E. stiedae has no central tubules and thus differs substantially from the centriole found in the merozoites.

In the proximal part of the basal body of Pseudotrichonympha (Gibbons and Grimstone, 1960) there is a central cylinder somewhat reminiscent of the central tubule in the centriole of merozoites, but the other ultrastructures of the basal body of this flagellate and of the merozoite centriole are different. Consequently, the centriole of the merozoite has its own unique structure. Nevertheless it most resembles this cell organelle. Its position near the nucleus corresponds completely with the position of the centriole in the cells of the Metazoa and various Protozoa.

Apparently this structure is not accidental in the merozoite and belongs to the merozoite itself. What seems strange is its very rare occurrence in the merozoites, despite their rather large size. The less bulky cytostome (micropore) can be seen in merozoites in ultra-thin sections much more often than the centriole. It may be that the centriole exists only in those merozoites which ultimately turn into microgamonts. But this supposition demands proper confirmation. So far the centriole has not been seen in trophozoites. Also undetermined at the early stage of microgametogenesis is the formation of a number of centrioles corresponding to the number of nuclei. In the microgamonts the basal bodies are formed at the surface of the cell, but not once was their formation seen in connection with centriole reproduction. Undoubtedly, attention should be directed in future studies to the mechanism of the process by which basal bodies are formed in the microgametocytes in connection with the observation of a centriole at a previous stage, i.e., in the merozoites.

SUMMARY

Structures were seen in the merozoites of E. intestinalis which were markedly resembled a centriole. Nine tubules formed ringlet near the nucleus, with one more tubule in the center. This structure, tho similar to a typical centriole, differs in that it has a central tubule.

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