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## Life Cycle of *Eimeria stiedae*

KNOWLEDGE of the early development of *Eimeria stiedae*, before the appearance of trophozoites in the liver of its rabbit host, is remarkably scanty. After initial penetration of the duodenal epithelium by the sporozoites, the earliest observation of trophozoite formation has been 72 h after infection. The route of migration of the sporozoites during this period has long been a subject for speculation, and the most favoured theory has been passage to the liver from the mesenteric lymph node in the portal blood. Slater, Quisenberry and Fitzgerald[1] gave support to this theory by reporting the presence of sporozoites in the mucosa after 5–9 h, free and in monocytes in the mesenteric lymph nodes and in monocytes in the peripheral blood 16–20 h after infection.

One of the principal technical difficulties in the study of specific coccidia has been the difficulty in keeping experimental animals free of extraneous coccidial infection. The work described in this preliminary communication has been carried out using specific pathogen free (SPF) animals which were entirely free from coccidia, and maintained during experiment in plastic film isolators similar to those used for maintaining gnotobiotic animals. The use of this type of animal and equipment has made possible a different approach to the study of *E. stiedae*.

Previous research was directed largely towards the demonstration of the sporozoites in the tissues by direct staining or labelling. I have tried to trace the spread of the organisms by an indirect method of tissue inoculation from experimentally infected donor rabbits into non-infected recipient rabbits. By maintaining their SPF condition, the recipients were then used as indicators for the presence of viable sporozoites in tissues where they had not previously been demonstrated by other techniques.

Donor rabbits dosed with $2\text{–}4 \times 10^6$ sporulated *E. stiedae* oocysts by stomach tube were killed 12, 24 and 48 h after infection, and samples of lymph node and bone marrow were aseptically removed. From the donor rabbits culled after 48 h, liver and blood buffy layer, axillary lymph node and washings from the coelomic cavity were also taken. These tissues were homogenized and injected intravenously into 8 week old recipient rabbits previously sedated with 5 mg of promazine hydrochloride.

Recipients were examined daily for signs of infection, and faecal samples were taken for flotation tests. Animals were killed at the first appearance of oocysts in the faeces or 16–20 days after inoculation if there were no signs of infection.

The results showed that viable sporozoites were present in the mesenteric lymph node after 12 h, in bone marrow after 24 h and in liver and buffy layer after 48 h. Infection could not be induced from the axillary lymph node, washings from the coelomic cavity or from control donors.

Liver tissue taken after 48 h produced severe coccidiosis in test animals. But the apparent presence of sporozoites in blood and bone marrow after 24 h indicates a widespread distribution of organisms with possible involvement of the liver much earlier in infection than previously appreciated. Viable organisms were present in the mesenteric lymph node as early as 12 h after infection, producing mild hepatic lesions in the test rabbits. The increasing severity of lesions with tissue taken at 24 and 48 h suggests that there may be a steady accumulation of organisms in this tissue.

It is hoped that further tests and quantitative studies on tissue taken at different time intervals after oral infection will help to further clarify the situation regarding the spread of sporozoites during the first 72 h after infection.

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## Respiration, Growth and Maintenance in Plants

THE dependence of plant respiration on photosynthesis and dry weight interests the crop scientist, and recently McCree[1], in order to account for his data on white clover, put forward the following simple equation to describe whole plant behaviour

$$R_d = kP_g' + cW \qquad (1)$$

where $R_d$ is the dark respiration rate, $W$ is the plant dry weight, and $k$ and $c$ are constants. $P_g'$ is a gross photosynthetic rate which is calculated by using

$$P_g' = P_n + R_d$$

where $P_n$ is the net photosynthetic rate. In this communication equation (1) is derived theoretically using a straightforward extension of Pirt's discussion of yield and maintenance in bacterial cultures[2]. The derivation gives a better understanding of the role of the constants $k$ and $c$ in McCree's equation. The relevance of dark and light respiration to the following analysis (where this distinction is at first ignored) and to McCree's equation is discussed later.

It will be assumed that in a time interval $\Delta t$ the amount of substrate $\Delta s$ generated by photosynthesis is $P_g \Delta t$, where $P_g$ is the gross photosynthetic rate, so that

$$\Delta s = P_g \Delta t \qquad (2)$$

In a steady state, this increment of substrate $\Delta s$ must be completely utilized during time $\Delta t$. It will be assumed that this substrate has only two uses—maintenance and growth. Thus a part of the substrate ($\Delta s_m$) is respired for the provision of maintenance energy, and a part ($\Delta s_g$) is used for growth

$$\Delta s = \Delta s_m + \Delta s_g \qquad (3)$$

All the substrate appearing in the term $\Delta s_m$ is respired, whereas only part of the substrate in $\Delta s_g$ is respired, the rest being turned into plant material. It will be supposed that $\Delta s_g$ may be partitioned

$$\Delta s_g = \Delta s_r + \Delta s_t \qquad (4)$$

where $\Delta s_r$ is completely respired, and the resulting energy is used to transform $\Delta s_t$ into plant material (this term includes both structural and storage components) without loss of mass; substrate and plant material are measured in units of $CO_2$ equivalents. The term, yield ($Y$), will be used here in the microbiological sense to mean increase in mass in plant material per unit mass of substrate used. The yield of the process of constructive growth ($Y_G$) is then given by

$$Y_G = \frac{\Delta s_t}{\Delta s_r + \Delta s_t} \qquad (5)$$

The observed yield ($Y$) is (compare ref. 2, equation 1)