Theileriosis, Babesiosis, and Anaplasmosis: Recent Research

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Much information on tickborne diseases of veterinary importance is included in other reports at this meeting. I shall review recent findings on 3 protozoan diseases: theileriosis, babesiosis, and anaplasmosis.

THEILERIOSIS

The current position on the taxonomy of agents causing theileriosis is ably stated by Wilde (1967) in a review of East Coast fever research.

Theileriosis research has been aided by Tsur's (1945) discovery that *Theileria annulata* can be grown in vitro in splenic explants, and by the discovery by Tsur et al. (1957) that *T. parva* also can be cultivated for long periods in splenic explants. Brocklesby and Hawking (1958) confirmed these results. Hulliger (1965) and Hulliger et al. (1964) showed that in tissue cultures of infected bovine lymphoid cells, the cells were infected by transfer of about half the theilerial particles during host cell mitosis. This finding was true of *T. parva*, *T. annulata*, and *T. lawrencei* (Hulliger 1965). In these studies, no micromerozoite formation was observed. Later, however, these workers (Hulliger et al. 1966) showed that if the incubation temperature of the cultures was raised to 41–42°C, microschizonts were formed, and that micromerozoites (probable infective forms for the red blood cell in vivo) were produced by budding. Growth of *T. parva* in tissue culture apparently results in a marked change in antigenic characteristics, as Hulliger et al. (1965) showed that there is no cross-protection between tick-induced East Coast fever and the disease produced by inoculating tissue-culture grown *T. parva*.

The immunity to *Theileria* is thought to be cell-bound, not humoral. Brocklesby et al. (1965) found that cattle inoculated with chopped splenic material from infected cattle had increased resistance to challenge with infected *Rhipicephalus appendiculatus* Neumann; 79% of the experimental cattle survived a challenging dose that killed 100% of the controls. In contrast, Hulliger et al. (1965) found that no protection was induced when cattle were given injections of *T. parva* grown in tissue culture. Neitz (1964) believed that the immunity in East Coast fever, as in most protozoal diseases, is really premunity, since he showed the persistence of erythrocytic forms of *T. parva* even though schizonts were not found. He felt that the so-called sterile immunity is explained by parasitemias too low for the parasite to be detected.

Brown et al. (1965), studying the hematologic changes in East Coast fever (*T. parva*) found a severe panleukopenia. However, in Mediterranean Coast fever (*T. annulata*) the leukopenia was slight and transient. Wilde (1963) attempted to stimulate a leukocytosis in East Coast fever-infected cattle by inoculating them with killed *Hemophilus pertussis* cells, but found that this procedure produced little or no response in infected cattle, whereas normal cattle responded with a marked leukocytosis. The concept of an autoimmune reaction against cells of the lymphoid series was invoked to explain these results.

The finding of a mild form of East Coast fever by Barnett and Brocklesby (1966) has given researchers another tool for studying the disease. In this form of theileriosis, carrier animals occur, so the persistence of the disease in the enzootic area can be explained. This milder form may also account for treatment successes reported previously. The general opinion is that chemotherapy is ineffective after the parasite reaches the lymphoid cells (Wilde et al. 1966).

Attempts to infect laboratory animals have been completely unsuccessful (Brocklesby and Vidler 1961).

Jarrett and Brocklesby (1966) made an electron microscopic study of *T. parva* early and late in the disease. They found a cycle of macroschizogony giving rise to multinucleated parasites which showed intense feeding activity and a cycle of microschizogony during which micromerozoites formed by budding from a residual body. No parasites were found at the time that lymph nodes were becoming hyperplastic, so a diffusible substance produced by the parasite was hypothesized to explain the hyperplasia.

BABESIOSIS

The world literature on babesiosis was reviewed recently by Riek (1968). Much of this discussion will be based on the Riek paper.

The classification of *Babesia*, especially of the higher taxons, is still controversial. Honigberg et al. (1964) included *Babesia* in the Sarcodina. This change is major for this group, and Riek (1968), on the basis of his studies of *B. bigemina* and *B. argentina* in the vector, the southern cattle tick, *Boophilus microplus* (Canestrini), feels it to be premature. The following lines of evidence, based on the work of Riek and his group, suggest that *Babesia* is properly classified with the Sporozoa.

1. Multiplication in cattle erythrocytes is largely by budding; binary fission was not observed. The budding is probably reduced schizogony, not a modification of binary fission.
2. Only certain of the intraerythrocytic forms ingested by the ticks survive to initiate the developmental cycle within the tick. This fact indicates the presence of a developmental cycle resulting in certain forms that are infective for the tick.