Bovine Babesiasis: Its Diagnosis and Control

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SUMMARY

The investigation was conducted to develop new systems and to evaluate existing ones for diagnosis and control of bovine babesiasis in Colombia, South America. Antigens of Babesia bigemina and Babesia argentina were isolated and were used in complement-fixation (CF) and rapid agglutination (RA) tests for the diagnosis of babesiasis in calves.

Three systems were evaluated for control of bovine babesiasis: (1) vaccination of calves with killed Babesia spp vaccine to produce resistance (based on sterile immunity), (2) premunition of calves with virulent Babesia spp and then administration of a chemotherapeutic drug to produce resistance (based on coinfectious immunity), and (3) chemoprophylaxis, using a babesia-cide having long residual activity. The 3 systems controlled bovine babesiasis under the conditions of the present experiments.

Epizootiologic conditions in enzootic areas, however, will indicate which system is preferable. In zones having a high population of the tick Boophilus microplus, premunition (system 2) is indicated; in areas where the tick population is controlled or in areas where cattle are at constant risk of tick exposure, vaccination with killed Babesia spp (system 1) or chemoprophylaxis (system 3) are indicated.

Although bovine babesiasis has been recognized as a serious economic disease for more than 80 years, practicable methods for diagnosis and control programs have not yet been obtained. This hemoprotozoan malady causes considerable production and death losses of cattle, especially in lowlands of tropical zones of the world where there are ticks. Since the natural transmission of Babesia spp is dependent on species of ticks, infection can be prevented by maintaining an adequate tick control program to keep cattle free from tick infestation. This can be accomplished by regular dipping of cattle, a method which has resulted in the eradication of bovine babesiasis in the United States. However, in the lowlands of subtropical and tropical areas of the world, a vector control program as a measure of Babesia spp control, while appealing, is virtually impossible to maintain, for various reasons. Since ticks occur abundantly in permanent grasslands of the tropics and they feed regularly on both wild and domesticated animals, it is difficult to eradicate them. At present, in countries where a tick control program is not possible to maintain, the only measure used to prevent production and death losses and to control the disease is a vaccination or a chemoprophylactic program.

A series of investigations were undertaken to test and evaluate 3 control systems for bovine babesiasis in tropical zones of Colombia, South America, where babesiasis is most prevalent. These systems included (1)
vaccination of susceptible calves with killed *Babesia* spp vaccine to produce a resistance to the disease (based on sterile immunity)\(^7,19,20,28,39\) and (2) premunition of susceptible calves with virulent *Babesia* spp isolated from cattle acutely infected with these parasites. Post-premunition reactions were controlled by instituting specific chemotherapy. After the calves had recovered from the premunition reactions, they developed a resistance (based on coinfectious immunity)\(^7,10,11,20,28,40,42\).

Additional experiments were directed at the control of bovine babesiosis with chemoprophylaxis (system 3). This system was based on a resistance against natural infection produced by a babesicide having long residual activity.\(^3\) The protective period lasts for a few weeks, and then the drug concentration gradually decreases to the point when *Babesia* spp can establish a mild infection. As a result of the interaction between drug and *Babesia* spp parasites, chemoprophylactically treated calves develop a resistance against babesiosis based on coinfectious immunity known as premunition.\(^5,19,47\)

This is a report of a more practicable serodiagnostic test for identifying cattle infected with *Babesia* spp and the results of evaluations of 3 systems for controlling bovine babesiosis under tropical conditions in Colombia, South America.

### Materials and Methods

**Serologic Diagnosis of Bovine Babesiosis—Complement-Fixation (CF) Technique**—Serums from experimentally and naturally infected cattle were subjected to the cr test for more than 3 years. These serum samples were obtained from cattle in enzootic areas in the Cauca River Valley, the Magdalena River Valley, the Llanos, and the northern coast of Monteria. Also, tests were made of serum samples from cattle having histories of experimentally induced babesiosis at our laboratory. Samples of serum were obtained from cattle before and after tick-borne or blood-borne infections.

Experiments were done to evaluate serologic techniques for detecting *Babesia* spp antibodies in calves and to develop a serodiagnostic test for babesiosis. The cr test used to detect *Babesia* spp antibodies in the serum of naturally and experimentally infected calves was modified from the procedures reported by Mahoney.\(^2,3\) Techniques consisting of isolation, purification, and titration of *B. bigemina* and *B. argentina* antigens; preparation of the hemolytic system; complement titration; and performance of the test in tubes and on the microtitration system are described in detail by Todorovic et al.\(^9\)

**Rapid Agglutination (RA) Technique**—*Babesia bigemina* and *B. argentina* were used for infecting calves and for producing the respective antigens. *Babesia bigemina* and *B. argentina* antigens were prepared from blood in which at least 20% of the erythrocytes were infected. High percentages of parasitemia were developed by serial passage of the parasites through 2 to 4 splenectomized calves. To enhance development of parasitemia, 9-a-fluoro-16-a-methylprednisolone\(^9\) (0.5 mg/kg) was injected intramuscularly (IM) for 3 days prior to infection. Following blood passage, thin and thick blood films of peripheral blood were prepared at 3 to 4-hour intervals to determine the percentage of parasitized erythrocytes. When the parasitemia remained constant during successive examinations, the organisms were passed to the next animal. After the 2nd or 3rd passage with *B. bigemina* and *B. argentina*, as many as 20% of the erythrocytes were parasitized.

Blood for the preparation of antigen was drawn into flasks containing ethylenediaminetetraacetic acid (EDTA; 1.2 g/L) from calves with 20% or more parasitemia. Plasma was removed by centrifugation at 1,065 g for 30 minutes at 4 C. The erythrocytes were washed twice in 0.85% NaCl solution. The last wash was in antibiotic saline solution containing 100 units of penicillin and 100 μg of streptomycin/1 ml of saline solution. Then, 5 volumes of sterile 0.35% NaCl was used to lyse the infected erythrocytes for 1 hour at 4 C.\(^47\) The lysate was centrifuged at 1,085 g for 30 minutes and resuspended in an equal volume of antibiotic saline solution. *Babesia* spp suspensions (35 ml) were passed through the French pressure cell\(^9\) at 1,200 psi and centrifuged at 10,000 g at 3 C for 30 minutes. The supernatant fluid was discarded, and the concentrated parasites were suspended in equal amounts of antibiotic solution. Suspensions were homogenized in TenBroeck tissue grinders. Fast green dye\(^9\) (1%) was added at the rate of 0.1 ml/25 ml of parasite suspension; this was mixed by shaking and was passed through the French pressure cell at 1,200 psi. Excess dye was removed from the antigen by decanting the supernatant fluid after centrifugation at 10,000 g for 30 minutes. After centrifugation and decantation of the supernatant fluid, the antigen pellets were suspended in equal volumes of antibiotic saline solution, homogenized in TenBroeck grinders, sonified in a cell disruptor\(^9\) for 3 minutes (using a 70-cycle power source), and tested for antigenic activity. Serial dilutions of antigen and drops of antigen (about 0.025 ml) were mixed with equal amounts of serially diluted serum samples. Reference samples of positive and negative sera for evaluating *Babesia* spp antigen reactivity and stability were obtained from 10 calves in a carrier phase of *Babesia* spp infection and from several normal calves originating from an area free from babesiosis. The test, done in disposable plastic trays, was similar to that used for the diagnosis of brucellosis. In addition, Brewer diagnostic cards\(^4\) were used to mix 2 drops of serum with 1 drop of *Babesia* spp card antigen, and were rotated for 5 minutes.

### Vaccination of Cattle with Killed Babesia spp Vaccine (System 1)—Vaccination experiments were done at the Palmira experimental station of the Colombian Institute of Agricultural Research (ICA) in the Cauca River Valley. Blood was collected from a splenectomized infected calf (20% of erythrocytes parasitized with *Babesia* spp) for preparation of killed *Babesia* spp vaccine. Blood was collected in EDTA (used as anticoagulant) by cannulation of the carotid artery. Blood was lyophilized in a freeze dryer\(^4\) in 20-ml portions and stored at −20 C. Before use, the vaccine was restored to 1/3 of the original volume with sterile distilled water, and 5 ml of this solution was injected IM into each calf.

Preparation of the killed *Babesia* spp vaccines was described in detail by Todorovic et al.\(^9\) The degree of protection in 10 vaccinated calves was assessed by packed cell volume (PCV) percentage of parasitemia, antibody titer, body weight, and number of deaths and their comparison with those of a comparable group of 5 nonvaccinated calves.

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\(^*\) Gibeo Biological Company, Grand Island, NY.

\(^*\) American Instrument Company, Silver Springs, MD.

\(^*\) Fisher Scientific Company, Houston, TX.

\(^*\) Hest System, Manassas, Va, Plainview, Li, NY.

\(^*\) Hyacinth, Westcott and Danne, Inc, Baltimore, MD.

\(^*\) The Virtis Company, Inc, Gardner, NY.
Fig 1—Babesia bigemina (A) and Babesia argentina (B) isolated from naturally infected cattle in Colombia and used for preparation of antigens for serologic tests and inoculums for premunition. Giemsa stain; X 1,000.

trol calves following field challenge. The field challenge was possible because none of these calves were subjected to any tick control program and thus were exposed to B. microplus.

**Premunition of Cattle with Virulent Babesia spp (System 2)**—Babesia bigemina and B.argentina were isolated from naturally infected calves in the Cauca River Valley. These isolates were frozen, using an empirical technique similar to that described by Barnett. The frozen material was thawed rapidly in a water bath (37°C) and passaged once through a splenectomized calf before it was used in premunition experiments. Infection of recently splenectomized calves resulted in 1% Babesia spp parasitemia within a mean prepatent period of 4½ days. Control of postpremunition reaction and determination of immune responses to premunition and challenge exposure to infected B. microplus were described in detail by Todorovic et al and Todorovic and Tellez.

Blood (5 ml) containing approximately 10^6 Babesia spp parasites/ml was inoculated IM into each of 10 calves. A new experimental compound, imidocarb (3,3'-bis-(2-imidazolin-2-yl)-carbanilide dihydrochloride), at a dosage of 0.75 mg of salt/kg of body weight was injected IM to control postpremunition reaction in the experiment. After all inoculations were done, the calves (5 controls and 10 principals) were examined twice each week for the presence of B. bigemina and B. argentina parasitemia by the use of thin and thick blood film technique, Pcv, and CF technique. Rectal temperature and body weight changes were also recorded. The immune responses of all calves were studied for 8 months. During field exposure, ticks were collected from all calves, preserved in absolute alcohol, and then identified.

Chemoprophylaxis (System 3)—The experimental compound imidocarb was used; the drug, received as a watersoluble salt, was dissolved in sterilized distilled water as a 10% solution and used within 24 hours after preparation.

This solution was administered IM at the dose level of 3 mg/kg of body weight.

A total of 5 calves was used in system 3—4 treated with imidocarb and 1 nontreated control. Four weeks after imidocarb inoculation, the 5 calves were inoculated with 100 ml of blood containing parasitized erythrocytes, 2% B. bigemina and 0.1% B. argentina. The prophylactic efficacy of imidocarb was determined by resistance of the calves to artificial and natural challenge exposure to Babesia spp. The therapeutic efficacy of imidocarb was determined by recovery of the calves from acute infection after they were treated. Blood (500 ml) from the 4 treated calves was inoculated into susceptible splenectomized calves to determine whether the 4 treated calves had Babesia spp infection before and after treatment. Treated calves were observed for signs of drug toxicity within 24 hours after treatment.

**Results**

Serologic Diagnosis of Bovine Babesiosis—Complement-Fixation Test—By the CF test, specific Babesia spp antibodies were detected on the 8th day after infection. Babesia bigemina and B. argentina in blood films stained by Giemsa were observed microscopically 3 to 8 days after experimental infection (Fig 1). The specific Babesia spp antibodies were detected an average of 3 to 5 days after the peak of parasitemia was reached. The peak of parasitemia with Babesia spp usually coincided with anemia and signs of acute babesiosis. Approximately 8 to 10 days after infection, the first CF titer was detected, and the titer persisted until the calf died. On postinfection day 10, a 2-plus reaction was observed in the microsystem, with a titer of 1:10. In the following 2 days, the sample usually gave a 4-plus reaction with the titer 1:40 (Fig 2). Good agreement existed between the CF reaction and the histories of calves having artificial and natural infections. Approximately 96% of serum samples from cattle having known babesiosis...
gave CF reactions; approximately 4% gave discordant reactions. The latter were especially seen in serum samples from several of the carrier calves.

Rapid Agglutination Test—Lysis of *B. bigemina* and *B. argentina*-infected erythrocytes with sterile 0.35% NaCl yielded an antigen composed of concentrated *Babesia* spp parasites. After they were passaged through the French pressure cell, *Babesia* spp parasites were ruptured, and the unstained *Babesia* spp antigen was grayish white and free of visible hemoglobin. Fine small particles of *Babesia* spp parasites were stained with fast green dye; this mixture was stable and uniform. Preliminary studies with this antigen revealed that a degree of specific agglutination reaction occurred with the serum from *Babesia* spp-infected cattle (Fig 3). The reaction was visible during a period from 3 to 10 minutes of plate agitation. However, nonspecific agglutination occurred with sera prepared from cattle without history of babesiasis, especially when stored card antigen was used.

Sterile Immunity (System 1)—Hematologic and serologic responses of calves injected with killed *Babesia* spp vaccine and exposed to infected *B. microplus* are shown (Fig 4). The 1st injection of killed *Babesia* spp

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**Fig 2**—Complement-fixation reaction in microtitration system for detection of specific *Babesia* spp antibodies. Row A contained serum from a cow infected with babesiasis with a titer of 1:160. Rows B and E show a titer of 1:40. Row D shows a titer of 1:320. Row E shows a titer of 1:80. Row C had serum from a noninfected animal. Row G had a known negative serum with a negative reaction.

**Fig 3**—Pattern of agglutination reaction in the rapid agglutination test for diagnosis of bovine babesiasis. Positive (A) and negative (B).
vaccine is indicated at week -8, and the 2nd injection at week -6. The tick-borne challenge is indicated by an arrow at week 0. Before vaccination, nonvaccinated control calves had PCV of 33% and vaccinated calves had PCV of 32%. After vaccination, PCV values remained in normal limits. The CF titers of 1:5 were detected in all vaccinated calves 4 days after vaccination.

At the time of field exposure to B microplus, all calves had approximately the same PCV (33%) values. Resistance to clinical babesiasis in calves given the killed Babesia spp vaccine was indicated by negative results of blood examinations for B bigemina and B argentina.

Nonvaccinated control calves had 0.5% Babesia spp parasitemia at 3 to 4 weeks after field exposure. At the time of Babesia spp parasitemia, the calves developed anemia with low PCV value of 18% and the calves were given specific treatment against babesiasis to prevent production and death losses. Eleven to 12 weeks after field exposure, all calves (vaccinated and nonvaccinated) developed clinical signs of anaplasmosis evidenced by Anaplasma marginale parasitemia and the PCV value decreasing to 20%. At this time all calves were treated with specific chemotherapy against anaplasmosis to prevent death losses. Differences between complement-fixing titers for Babesia spp in vaccinated and nonvaccinated calves were not statistically significant. All calves responded with rising CF titers of 1:5 to 1:80, and the titers persisted during the period of observation.

Coinfectious Immunity (System 2)—Hematologic and serologic responses of calves simultaneously injected with blood of calves acutely infected with B bigemina and B argentina and subsequently treated with imidocarb (0.75 mg/kg) to moderate the postpremunition reaction are shown (Fig 5). All preenunized calves re-

parasitemia disappeared the day after treatment. During the Babesia spp parasitemia, all inoculated calves developed anemia with a PCV of 23%. After drug treatment, all calves recovered from anemia, with PCV values returning to preinfection values of 30%. At the time of field exposure to B microplus ticks, all calves (control and preenunized) had PCV values of 32%.

After calves were challenge-exposed to B microplus ticks naturally infected with Babesia spp, all preenunized calves had a high degree of resistance to field exposure. Babesia bigemina and B argentina were not detected in stained thick and thin blood films, and PCV values were in normal limits (28–30%). The nonpreenunized control calves developed severe clinical signs of babesiasis at 4 to 3 weeks following field exposure—0.5% Babesia spp parasitemia and low PCV values (17%). All infected calves were treated against babesiasis to prevent production and death losses. Twelve weeks following field exposure, all calves (preenunized and control) developed clinical anaplasmosis, characterized by A marginale parasitemia, and they were given specific chemotherapy against anaplasmosis. Following this treatment, calves recovered from anemia and A marginale parasitemia. The CF titers to Babesia spp were first detected on postpremunition day 13, and these persisted with increasing levels of 1:20 to 1:80 during the experiment.

Chemoprophylaxis (System 3)—Results of chemoprophylactic treatment with imidocarb against bovine babesiasis and subsequent blood-borne challenge inoculation are shown (Fig 6). Within 3 hours after they were treated, all 4 treated calves showed salivation, lacrimation, coughing, and difficulty in breathing. At day 0, or 28 days following drug inoculation, all calves, including the control calf, were inoculated intravenously (iv) with Babesia spp-infected blood. At this time all 5 calves had PCV values of 32%. Three days after blood-borne challenge inoculation, the control calf not treated with imidocarb had 0.1% B bigemina and on day 5,
TABLE 1—Progress in the Serologic Diagnosis of Bovine Babesiosis

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Serologic technique</th>
<th>Species</th>
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<tr>
<td>Mahoney (1960)</td>
<td>Complement-fixation</td>
<td>Babesia bigemina; Babesia argentina</td>
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<tr>
<td>Lohr and Floss (1969)</td>
<td>Complement-fixation</td>
<td>Babesia bigemina; Babesia argentina</td>
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<td>Zwart et al. (1968)</td>
<td>Indirect fluorescent antibody</td>
<td>Babesia argentina; Babesia major; Babesia bigemina</td>
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<tr>
<td>Rosa and Lohr (1968)</td>
<td>Complement fixation</td>
<td>Babesia argentina; Babesia major; Babesia bigemina</td>
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<tr>
<td>Goldman et al. (1972)</td>
<td>Complement fixation</td>
<td>Babesia argentina; Babesia major; Babesia bigemina</td>
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<td>Churley et al. (1971)</td>
<td>Indirect hemagglutination</td>
<td>Babesia argentina; Babesia major</td>
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<tr>
<td>Brookshay et al. (1971)</td>
<td>Indirect fluorescent antibody</td>
<td>Babesia argentina; Babesia major; Babesia bigemina</td>
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<td>Donnelly et al. (1972)</td>
<td>Indirect fluorescent antibody</td>
<td>Babesia berbera; Babesia divergens</td>
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<tr>
<td>Joyner et al. (1972)</td>
<td>Indirect fluorescent antibody</td>
<td>Babesia berbera; Babesia divergens; Babesia major</td>
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<tr>
<td>Bourridge et al. (1973)</td>
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<tr>
<td>Curnow (1973)</td>
<td>Slide agglutination</td>
<td>Babesia bigemina</td>
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0.01% B. argentina parasitemia. Babesia spp parasitemia persisted until day 13 when the calf died with signs of acute babesiosis and with low PCV values (12%). The 4 calves treated with imidocarb 28 days before blood-borne challenge inoculation did not have any detectable Babesia spp, and their PCV values remained at a 31% level during the period of observations. Only the control calf showed a CF antibody response (a titer of 1:5) on day 8 following challenge with Babesia spp parasites.

Discussion

Serologic Diagnosis of Bovine Babesiosis—A characteristic feature of Babesia spp infection is that cattle which recover from acute infection become carriers of the respective hemoparasites. In these cattle, diagnosis cannot be made by examining blood films prepared with any of the contemporary staining methods. Thus, to identify a carrier animal, serologic methods are needed that will detect specific antibodies rather than the Babesia spp parasites themselves (Table 1). The CF technique was one of the earliest tests for the diagnosis of bovine babesiosis. A specific reaction for Babesia spp parasites has been useful in detecting CF antibodies in the serum of cattle with latent babesiosis; however, the practical application of the CF test was not conclusively demonstrated. The CF antigen used in our laboratory was obtained from the infected erythrocytes of cattle affected with acute babesiosis. Because of the impurities of these antigens, they can be used only in the CF test; under these circumstances, the variables and the difficulties of the CF technique become more pronounced and the dependability of the CF test lessens. Obviously, technical and mechanical errors which are inherent in other CF procedures also apply to our technique. However, when the test is carefully conducted, using an antigen prepared from cattle having high percentages of B. bigemina or B. argentina parasitemia, a minimum of error in test accuracy and specificity should occur.

The preliminary results of the RA test for detection of specific agglutinins in sera of cattle infected with Babesia spp are encouraging, and methods of eliminating some inherent problems of specificity of the agglutination reaction are being studied. Adjusting the agglutination reaction to detect a small concentration of Babesia spp antibodies, care is taken so that the agglutinating antigen is not overly sensitive, causing it to be reactive with serum samples from noninfected cattle. Studies are underway to better evaluate the methods of isolation of the card agglutinating antigen as well as to determine specificity of the card agglutination reaction. In addition, a problem with the preservation of Babesia spp agglutination antigen was found, and different techniques for its preservation are being tested.

Methods devised to date for serologic diagnosis of bovine babesiosis obviously remain imperfect. Improvements must be sought and serologic procedures standardized. Nevertheless, the admittedly imperfect techniques reported by several investigators (Table 1) now available are already capable of diagnosing bovine babesiosis. As a result of the investigations and observations by others, it is apparent that more research is needed for the perfection of a serodiagnostic technique for bovine babesiosis.

Sterile Immunity—The theoretical concept for these experiments was based on the possibility that sterile immunity might be induced. Although sterile immunity is not usually encountered in blood protozoan infections, it does occur naturally in Theileria parva infections. Mahoney reported that the species-specific babesia antigen required for cross-protection immunity between different strains of Babesia spp parasites was found in the infective plasma during the acute phase of infection. Todorovic et al found that different Babesia spp preparations had different immunogenic properties. Protection was more evident in cattle injected with a vaccine prepared from plasma rather than from infected erythrocytes. Results of experiments reported here indicate that cattle inoculated with blood containing killed Babesia spp developed a resistance to field exposure to infected B. microplus ticks, whereas, nonvaccinated cattle kept under the same field conditions developed clinical babesiosis. Following field challenge, new difficulties were encountered with A. marginale infection, causing severe anemia in experimental cattle. This indicates that control of babesiosis alone is not economical under most tropical conditions.

The freeze-dried inactivated B. bigemina and B. argentina vaccines as described here would seem to be capable of imparting some protection against babesiosis. The sterile immunity reported in the present study appears more effective than the form of immunity reported by Australian workers. This difference may be attributable to the fact that intact calves were used in the present experiments, and the killed Babesia spp vaccine was prepared from blood. Mahoney and Goodey studied the immunogenic reactions of splenectomized calves inoculated with plasma harvested from calves with acute infections and they found protection, characterized by a sudden disappearance of B. argentina from peripheral blood of the calves, only in the experiments in which the challenge inoculum (parasites) was antigenically
identical with the infective plasma used for immunization. Similar results were reported by Todorovic et al., who studied the degree of protection produced by 2 preparations—plasma and infected erythrocytes. Seemingly, the immunogenic material was present mainly in the plasma collected during the acute stage of infection, especially at the peak of Babesia spp parasitemia, rather than in the infected erythrocytes. The complete protection observed in cattle vaccinated with both preparations can be explained by differences reported by other investigators. Results of experiments designed to ascertain the mechanism of sterile immunity to bovine babesiosis strongly indicate this form of immunity to B. bigemina and B. argentina exists and has an important role in the development of acquired immunity to bovine babesiosis.

Coinfectious Immunity—The coinfectious immunity in bovine babesia is referred to as a premunition,49 labile infection, latent infection, or immunitas non sterilizans.50 The immunity persists so long as the animal remains a carrier of the infection. Several variables must be solved before premunition can be recommended as a method of immunizing cattle on a large scale for the control of babesia.5,6,11,20,45,44 These variables include (1) volume of blood used as inoculum; (2) number, infectivity, and history of Babesia spp parasites; (3) phase of infection when blood is collected from cattle either recovered from, or reacting to, Babesia spp; (4) storage of infected blood from time of collection to time of inoculation; (5) age and breed of animals used for premunition; and (6) drugs used for moderating the postpremunition reaction. These factors, associated with premunition of Colombian cattle and to limit the number of variables, were discussed.44,48 In the present work, infected blood used as premunition inoculum was always obtained from a splenectomized calf acutely infected with Babesia spp; the infective inoculum contained approximately the same number of Babesia spp parasites (107/ml). Callow and Tammemagi51 reported that low infectivity for B. argentina was the cause of vaccination failures in the field. According to them, 1/3 of cattle inoculated with 5 ml of blood from 6 different carriers of B. argentina between 1 and 6 months after primary infection failed to become infected. In the present experiments, a splenectomized calf was used to produce adequate infection, so that the blood inoculum taken from this calf contained enough Babesia spp parasites to accomplish premunition. The second obstacle against an effective premunition program is severity of the postpremunition reaction. In view of the effectiveness of imidocarb against B. bigemina and B. argentina, this problem would not be serious except that cattle are made susceptible if the compound is used in excess and sterilizes the infection.

Plata52 reported on the common distribution of bovine babesia and anaplasmosis in Colombia and the high frequency of concurrent Babesia spp and A. marginale infections in cattle. Findings in the present work confirmed his observations and indicated the need to develop simultaneous control programs for babesiosis and anaplasmosis in tropical zones of Colombia.53,44

The mechanism of acquired immunity to bovine babesiosis is complex and is not completely understood. In a study of immunity to babesiosis, it became apparent that the state of equilibrium which develops between the bovine host and the hemoprotozoan parasite is not permanent.55 The parasite will ultimately be eliminated in the absence of continued infection by ticks, and the animal may become susceptible if reinfestation occurs after a certain lapse of time.56 In enzootic areas in Colombia, due to reinfestation from infected ticks, it is not unusual for cattle to retain immunity for several years.

Chemoprophylaxis—There is an obvious need for drugs that can be given prophylactically to susceptible cattle at risk of exposure to Babesia spp. In Anaplasma—B. bigemina and B. argentina, the mechanism of imidocarb action is not clearly understood. Severe toxic reactions appeared in cattle injected with imidocarb57; salivation, lacrimation, labored breathing, coughing, and even death were observed if the drug was administered at dose level of 3 mg/kg. These effects were less severe when imidocarb was administered intravenously or subcutaneously.

Potential use of imidocarb as a prophylactic drug is indicated in a number of circumstances.5,18,47 To protect susceptible cattle moved from a tick- and Babesia-free country through a tick-infested area, imidocarb can be used to replace hazardous premunition procedures with virulent Babesia spp. Furthermore, administration of imidocarb and exposure of cattle to ticks infected with Babesia spp might help in the development of natural coinfectious immunity without severe postpremunition reactions. The prophylactic effect of imidocarb may be effective for a longer period than any babesiacide tested. Severe toxic effects were found which might limit its use, but these need to be studied.47

The actual epizootiologic conditions determine which of the 3 control systems should be used. In an area where the tick population is not effectively controlled, the system of premunition is indicated. In tick-free zones or areas where cattle are at a constant risk of tick exposure and babesiosis, cattle either could be vaccinated with killed Babesia spp vaccine or could be treated chemoprophylactically.

References

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