INFECTION OF BABESIA BIGEMINA IN CATTLE
AND METHODS OF CONTROL

SCRIPT

By
JUANIS YAJUNI
B 161100

FACULTY OF VETERINARY MEDICINE
BOGOR AGRICULTURAL UNIVERSITY
1985
**SUMMARY**

*Babesia bigemina* is the species which occurs mostly throughout the tropics and subtropical areas. It gains access to the susceptible cattle through the bite of an infected tick and penetrates an erythrocyte. The pathogenesis of *B. bigemina* is considered to be as highly pathogenic and may cause heavy mortality in susceptible stock. Infected cattle rapidly become dull and listless and lose their appetite, the erythrocytes are destroyed resulting anaemia, icterus, emaciation, weakness, and a drop in milk production. Death and loss of productivity due to *B. bigemina* account for the economic loss.

Trypan blue was the first drug to be used in treating *B. bigemina* but is now less frequently used because of its discoloration effect of flesh. Acaprin at the rate of 1 mg / Kg given subcutaneously and Acridine derivates given intravenously 15 to 20 ml of 5% solution or 5 ml of a 5% citrated solution given intramuscular are most widely used. Berenil is also very effective at the rate of 2 - 3 mg / Kg given by deep intramuscular injection.

Ticks are the only vector. Therefore babesiosis due to *B. bigemina* is best controlled by eliminating the tick. Immunization of susceptible stock, treatment of infected animals, and the control of stock movements are other methods of controlling.
ACKNOWLEDGEMENTS

The author wishes to place on record his deepest sense of gratitude to Dr. Gatut Ashadi as the adviser and Drh. Umi Cahyaningsih as member for their help, encouragement and guidance in the preparation of this script.

He also thankfully acknowledges his gratefulness to the dean of the Faculty of Veterinary Medicine and all the member of his staff for assisting and guiding him during the course of the study at the university.

The author also wishes to express his sincere thanks to the Chief Minister's Department in Sabah for awarding the scholarship and other facilities while studying in Bogor. To all librarians of the University libraries and the Research Institute for Animal Disease Library in Bogor, the author express his gratitude for their assistance in various ways.

Last but not the least, the author records his deepest appreciation to his parents, brothers, sisters and beloved wife and children for their prayers, encouragement and help aimed at inspiring the author during the course of his academic enterprise.
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By

JUANIS YAJUNI, Degree in Veterinary Medicine (1984)
B 161100

APPROVED BY

Dhr. Uni Cahyaningsih
Member

Dr. Gatut Ashadi
Adviser

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SCRIPT

A Script
Presented to the Faculty of Veterinary Medicine
of Bogor Agricultural University
In Partial Fulfillment for the Degree of
Doctor of Veterinary Medicine
( Dokter Hewan )

By
JUANIS YAJUNI
Adviser : Dr. Gatut Ashadi
Member : Drh. Umi Cahyaningsih

FACULTY OF VETERINARY MEDICINE
BOGOR AGRICULTURAL UNIVERSITY
1985
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I. INTRODUCTION

The Babesia are intraerythrocytic, tick-transmitted protozoan parasites. Babes (1888) in Romania was the first to describe Babesia parasites in the blood of cattle and sheep. Various species of Babesia are known to infect cattle, however, the most economically important are those caused by Babesia bovis and Babesia bigemina. Babesia bigemina was accurately described by Smith and Kilborne (Burner, 1973). These workers also made the discovery of epochal importance because this was the first protozoan disease shown to be so transmitted. In 1930, Babesia sp. had been described in all of the domestic animals, the geographical distribution of the parasite was world wide and ticks were the only vectors. Babesiosis is presently considered as one of the most important constraints in production of cattle in most regions with tropical and subtropical climate.
II. LITERATURE REVIEW

A. HISTORY AND OCCURRENCE

*Babesia bigemina* was first discovered by Smith and Kilborne in the United States in 1893. The cause of an important disease of cattle called Tick fever, red water fever, piroplasmosis and formally in North America, Texas fever. Hosts principally the bovine, also in zebus, water buffalo (Gibbons, 1963) and deer (Soulsby, 1978).


In the cattle body, *B. bigemina* is present in the red blood cells during the fibrile stage in the form of round or pear-shaped bodies (Udall, 1954). According to Hall (1977) and The British Veterinary Associations (1976), the incidence of the infection of *B. bigemina* can be seasonally related to the occurrence and activity of the vectors. Movement from the free areas into enzootic areas results in high morbidity and mortality rates in cattle which have either never been contact with the causative protozoan or have been
contact with it for at least a year and have thereby, partially or completely lost in their immunity.

Therefore it is a disease most commonly encountered in cattle in transit to slaughter or to seasonal or regional pasture, and rarely appears in cattle born and raised in enzootic areas whose premunition is established gradually as the natural resistance of young animal subsides. When it does occur in cattle in enzootic areas its appearance is due to the stress of intercurrent debilitating disease or to starvation or parturition. It is also common to find that intercurrent infections with another micro-organisme like *Anaplasma*, may cause break down of premunity and initiation of babesiosis. (Hall, 1977 and Blood et al., 1979)

European breeds are much more susceptible than zebus, probably because of tick resistance of the latter breed. Nevertheless, both are likely to become infected if they are introduced into enzootic areas without premunition. According to Blood et al. (1979), heaviest losses occur in marginal areas where the tick population is highly variable depending on the environmental conditions. The morbidity rate is such circumstances is often 90% and the mortality may be of the same order. With early, effective treatment the mortality rate can be reduced to 5%. *Babesia bigemina* usually infect cattle more than one year of age.
According to Kreier (1977), it is of major economic importance in cattle because of the excessive husbandry methods employed to raise this animal. In enzootic areas cattle usually become infected while relatively young, suffer only mild reactions, and a subsequently resistant to severe clinical infection. Previously uninfected adult cattle are highly susceptible. The disease is mostly prevalent in bushy or wooded areas which are favourable habitats for vector ticks. According to Gibbons (1963), the incidence of infection decreases in proportion to the effectiveness of tick control measures. The greatest infection rate is in animals in the 6-12 months age group and infection is uncommon in animals over 5 years of age. Animals under one year of age are infected predominantly with Babesia bigemina. (Blood et al., 1979)

Babesia bigemina reactors examined in Eastern plains of Colombia showed that 40% of the calves between 1 and 3 months of age were reactors, (Wells, 1977) while 65% of the calves between 4 and 6 months were reactors (Table I). 65% of the 7 to 12 months old group were reactor; 48% of the 13 to 24 months group; and 30% of all cattle tested over 24 months of age were Babesia bigemina reactors. Wells (1977), further stated that there were 68% of the 120 pregnant cows tested for babesiosis due to B. bigemina were reactors. The earliest age of infection with
Babesia bigemina was two weeks with the latest age of infection being 34 weeks.

<table>
<thead>
<tr>
<th>Age (Months)</th>
<th>No. of Cattle tested</th>
<th>No. of Reactors</th>
<th>Percent Reactors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>144</td>
<td>66</td>
<td>46%</td>
</tr>
<tr>
<td>4-6</td>
<td>254</td>
<td>165</td>
<td>65%</td>
</tr>
<tr>
<td>7-12</td>
<td>416</td>
<td>269</td>
<td>65%</td>
</tr>
<tr>
<td>13-24</td>
<td>412</td>
<td>197</td>
<td>48%</td>
</tr>
<tr>
<td>&gt; 24</td>
<td>660</td>
<td>194</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1886</strong></td>
<td><strong>891</strong></td>
<td><strong>47%</strong></td>
</tr>
</tbody>
</table>

Table I. Percentage of infection in cattle according to age (Wells, 1977)

B. CLASSIFICATION

The taxonomy of Babesia sp. has always been the subject to debate because sufficient knowledge of their biology has never been available to determine their correct position among the Protozoa. Many investigators assumed they were related to Telosporidia but were later differentiated from Theileria. (Weinman and Ristic, 1968).

Babesia sp. were usually placed in the class (or Subphylum) Sporozoa (Leuckart, 1879 in Kreier, 1977), a class originally erected on parameters related to a method of sexual reproduction that result in the formation of spores and oocysts.

Regendanz and Reichenow (1933 in Weinman and Ristic, 1968), considered that the Babesia sp.; because of the
amoeboid movement in some stages of development and the absence of sexual reproduction, were more closely related to the Rhizopoda than Sporozoa. This view was supported by the work of Muratov and Cheissin (1959, in Weinman and Ristic, 1968) and Poljansky and Cheissin (1959, in Weinman and Ristic, 1968), who could not find evidence of sexual reproduction in Babesia bigemina and Babesia bovis. Because of repeated failure to demonstrate a sexual phase in the babesial development, the Committee on Taxonomy and Taxonomic Problems of the Society of Protozoologist removed them from the class Sporozoa and placed them with the amoebae in superclass Sarcodina; class Piroplasmida; order Piroplasmida (Mc Diarmid, 1969).

In recent years knowledge of biology of Babesia sp. and that of the Sporozoan generally has increased. A very close morphological relationship between Babesia and established members of this class was demonstrated by ultrastructural studies (Scholtyseck et al., 1970 and Scholtyseck, 1972 in Kreier, 1977). However the question of sexual reproduction among the Babesia was not resolved. Levine (1969, 1970 in Kreier, 1977) concluded that the formation of spores and oocysts was not a suitable characteristic for the basic of the primary classification. He proposed a new Subphylum Apicomplexa, based on the presence, in at least one stage, of the structure of the polar complex revealed
by the electron microscope. This new Subphylum contains two class, i.e., the Sporozoea (Leuckart, 1879 in Kreier, 1977) whose members produce oocysts and spores, and the Piroplasmea (Levine, 1961 in Kreier, 1977), that reproduce by asexual methods only. In the latter class there is one order, Piroplasmorida (Wenyon, 1926 in Kreier, 1977) which contains the family Babesiidae (Poche, 1913 in Kreier, 1977). However, this proposal may not be the final solution for the Babesia because the assumption that they do not undergo sexual reproduction may not be justified.

The weakness in the past in including piroplasma in the class Sporozoa has depended on ignorance of their development in both the vertebrate and invertebrate hosts. The development of *B. argentina* and *B. bigemina* in the tick *Boophilus microplus*, described by Rick (1964a, 1966 in Weinman and Ristic, 1968), has provided new evidence which may permit a more accurate classification of this group. Therefore in the light of the evidence now available there would appear to be no doubt that the genus *Babesia* belongs to the class Sporozoa (Weinman and Ristic, 1968). Levine (1971 in Kreier, 1977) was the one who decomented the true identity of *Babesia* species according to their measurement and *Babesia bigemina* comes under large species.
polar rings, rhoptries, and micronemes. A concid is not present. The cytoplasm contains free ribosomes; a reduced, smooth endoplasmic reticulum; a nucleus with two unit membranes; and mitochondria-like vesicles that are double-membrane structures which presumably function as mitochondria. A cystostome is lacking, although the cells are capable of ingesting the host cell cytoplasm at any point of the parasite membrane. Once within the cell, the merozoite begins to lose the pellicular complex, micronemes, and rhoptries. (Farmer, 1980)

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Fig. 1. Erythrocytic development of Babesia bigemina. A, Vermicule penetrating an erythrocyte. B, Amoeboid stage. C, Binary fission of trophozoite. D, Characteristic bigemina form: each is capable of repeating the cycle. (Farmer, 1980)

Fig. 2. Diagrammatic representation of a trophozoite of Babesia bigemina. (Farmer, 1980)
D. DIAGNOSIS

Diagnosis of *Babesia bigemina* infection is based on clinical signs of fever, hemoglobinuria, anaemia and icterus, and confirmed by the detection of parasites in the peripheral blood. Both thick and thin blood smears may be employed, being stained by one of the Romanowsky stains; however, the organisms may not always be present, and it may be necessary to examine a number of smears to establish their presence. In the cerebral form, examination of cerebral capillaries is necessary (Soulsby, 1978). In the endemic areas, high fever associated with hemoglobinuria and anaemia is suggestive of *Babesia* infection, and frequently animals are treated with recourse to blood examination. For wider surveys the Complement Fixation Test (CFT) of Mahoney (1962) may of value especially in those animals where the level of parasitemia is low. *Babesia bigemina* according to Kreier (1977), can be recognized in Giemsa-stained kidney smears up to 8 hours after death and in brain for 16 to 28 hours. Babesiosis can also be diagnosed from autopsy or necropsy. When the infection is due to *B. bigemina*, the kidneys are commonly enlarged and dark, and the bladder may contain red-brown urine. The blood is almost always thin and watery (Belschner, 1974). Patches of congestion in varying amounts are present along the intestinal tract. The
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carcass shows the general appearance of anaemia, such as gelatinous exudation in various parts, together with paleness of the muscular tissue.

To prove diagnosis in some cases, it may be necessary to reproduce the disease in a susceptible healthy cattle by parenteral inoculation of 5 to 10 ml of fresh or citrated blood from the suspect (Gibbons, 1963).

E. TRANSMISSION

Under natural conditions transmission is effected and initiated with the introduction of sporozoites into the blood through the bite of tick (Cheng, 1964). Numerous species of the genera Boophilus, Haemophysalis, Ixodes, Rhipicephalus and Hyalomma have been implicated. Transovarian transmission (Fig. 3) is regarded as the commonest method in most species, the parasite passing through the egg to the next generation of the tick. Ticks feeding on non-susceptible hosts do not lose their infection.

Transference of parasitaemia blood from an infected to susceptible animal through the agency of biting flies or unsterilised surgical instruments is theoretically possible but appears to be unimportant.

The Babesia survive in areas of endemic infection by passing from one generation of tick to the next,
**Fig. 3.** Development of *Babesia bigemina* in *Boophilus microplus* (Adam, 1971).

**Fig. 4.** Postulated life cycle of *B. bigemina* in the cow and the tick. (Ristic and Kreier, 1981).
and by carrier cattle providing a source of infection to the tick population. Moreover, ticks are not cleaned of the infection when feeding on non-susceptible hosts, and a carrier state probably exists in other domestic and wild animals (British Veterinary Association, 1976). Infection can also be established in a susceptible host by parenteral inoculation with blood or with splenic or hepatic fluid taken from an infected animal. It can also be transmitted experimentally from infected to susceptible cattle by intravenous, subcutaneous, intramuscular, or intraperitoneal inoculation of blood. A few out-breaks of the disease have been traced to surgical procedures, such as de-horning, in which there was no sterilization of instruments. The blood from animals carrying inactive infection was thus transferred to susceptible animals (Gibbons, 1963). According to Farmer (1980), ticks responsible for transmission of Babesia bigemina are the ixodids, Boophilus annulatus and B. microplus. Schmidt (1981), reported that Babesia bigemina is transmitted by tick of the genus Boophilus, and the distribution of babesiosis is limited by the distribution of the tick. The tick after feeding, mature, and mating on a single host. After engorging and mating, the female drops to the ground, lays her eggs that have been infected with Babesia bigemina through transovarian transmission, and dies. The larval, six-
legged ticks that hatch from the egg climb onto vegetation and attach to animal that are brushed by the plants. In other parts of the world it occurs in a one-host tick, two and three-host ticks serve as host and vectors of Babesia bigemina. In these cases, transovarian transmission is not required and may not occur. All instars of such ticks can transmit the disease. Soulsby (1978), stated that one host-tick: Boophilus annulatus, N. America; B. calcaratus, N. Africa; B. decoloratus, S. Africa; B. microplus, Australia, Panama, S. America : Two-host tick : Rhipicephalus evertsi, S. Africa; R. bursa, S. Africa : Three-host tick : Haemaphysalis puntata, Europe and Eurasia; Rhipicephalus appendiculus, S. Africa. He further said that there is no conclusive evidence that Babesia bigemina can be transmitted mechanically by blood-sucking arthropods. On rare occasion it seems that intrauterine transmission may occur from mother to foetus, but this mode of infection does not seem to be of any significant importance in the general epidemiology of babesiosis.

F. PATHOGENESIS

Babesiosis is a highly pathogenic disease of animals and may cause heavy mortality in susceptible stock (Weinman and Ristic, 1968). On introduction into the blood stream of a susceptible host, the piroplasms
invade the red blood cells and begin to divide into paired daughter cells. As the parasitized erythrocytes are destroyed, the daughter cells separate and enter new red blood cells. The destruction of the red blood cells and loss of hemoglobin into the bloodstream result in anaemia, hemoglobinuria and icterus (Davis and Anderson, 1971).

In typical acute cases in adult cattle, the red cell count may drop to 1 to 2 million per cubic millimeter of blood, hemoglobinuria and icterus are marked, and death may result from anoxemia, particularly under stress of handling or exercise. In milder infections of young or partially immune animals and in chronic infection the destruction of red blood cell is usually not sufficient to cause hemoglobinuria, although anaemia and debilitation may develop in prolonged cases (Gibbons, 1963).

According to Burner (1973), the incubation period following tick transmission varies between 8 to 10 days. The multiplication of *Babesia bigemina* in the peripheral, reaches a peak with the development of clinically detectable haemolysis result after an incubation period of 7 to 20 days (Blood et al., 1979). If the animal survives, it becomes a carrier in which a harmless, subclinical infection is maintained by a delicate immunological balance between protozoa and antibodies. This balance is disturbed by environmental stress,
especially transport and deprivation of food, and intercurrent disease. In this carrier state the animal is resistant to infection and it persists for about a year.

According to Soulsby (1978), the first evidence of the disease is a spectacular rise in body temperature. The high fever lasts for 2–7 days or more and during this period a profound anaemia frequently develops. There is hemoglobinuria and cardiac palpitation. At the height of fever, up to 75% of red blood cells may be destroyed, and the mortality may be very high in acute cases, death occurring 4–8 days after onset of clinical signs. During the exit of *Babesia bigemina* parasites from infected cattle erythrocytes, two or more parasite-associated proteolytic enzymes are released (Ristic, 1981) into the plasma. These enzymes and/or similar parasite metabolic products are believed to interact with blood components and are ultimately responsible for several of the pathologic signs and symptoms. Ristic (1981), further stated that infection of *B. bigemina* in spleenectomized calves showed a decrease in serum potassium levels in some animals while urine potassium levels were increased in all animals.
G. CLINICAL SIGNS

The clinical manifestation of babesiosis varies from a very mild and symptomless infection to acute and often fatal episodes, depending on the species of Babesia involved and the susceptibility of the host animal. In general the most severely pathogenic form of the disease is seen in infection of highly susceptible adult cattle with B. bigemina (British Veterinary Association, 1976). The first symptom is a sudden rise in body temperature to 41°C (Schmidt, 1981). This may persist for a week or more. Infected animal rapidly become dull and listless and lose their appetite. Up to 75% of the erythrocytes may be destroyed in the fatal cases, but even in milder infections so many erythrocytes are destroyed that anaemia result. Mechanisms for clearance of hemoglobin and its breakdown products are overloaded, so jaundice results, and much excess hemoglobin is excreted by the kidneys giving the urine the red color. Chronically infected animals remain thin, weak, and out of condition for several weeks before recovering. According to Belschner (1974), with milking cattle a drop in milk-production is generally the first symptom noted. Rumenation ceases, respiration is accelerated. There is great weakness, the animal stands with back arched, head drooped out, ears drooped, and often saliva hangs in strings from
the mouth. The animal moves with difficulty and with staggering gait. It may be constipated and pass hard dung, often coated with mucous. The mucous membranes of the eye and mouth, which are at first very red, change to white, indicating severe anaemia. Weakness becomes intense; there is a sudden drop in temperature to below normal shortly after death, which commonly occurs in three to four days or even less from the onset of the disease. At the stage of jaundice becomes evident the heartbeat becomes fast and accentuated. The heartbeat may be so forceful that it may be detected some distance from the animal (Hall, 1971).

Often the first sign is that the animal isolates itself from the heard (Seddon, 1966), and becomes uneasy. Station cattle frequently leave the mob and seek shade. The febrile stage usually lasts for about 3 weeks (Blood et al., 1979). Pregnant females may abort (Gibbons, 1963 and Blood et al., 1979). Occasional animals infected with *B. bigemina* show cerebral babesiosis manifested by incoordination followed by posterior paralysis or by mania, convulsions and coma (Soulsby, 1978 and Blood et al., 1979).

**H. PATHOLOGY ANATOMY**

On necropsy the abdominal cavity, hyperemic spots may be observed on the omentum (Udall, 1954), the spleen
is enlarged, swollen and a soft, pulpy consistency, the liver is grossly enlarged and dark brown in colour, and the gall-bladder is distended with thick granular bile. The kidneys are enlarged (Belschner, 1974 and Blood et al., 1979). The lungs are swollen and oedematous (Seddon and Albiston, 1966). The pericardium contains some blood-stained exudate and there are petechial haemorrhages under the epicardium and endocardium (Seddon and Albiston, 1966 and Blood et al., 1979).

In animals which have suffered a more prolonged illness, acute lesions are absent except that petechial haemorrhages may be present on the heart (Seddon and Albiston, 1966). The carcase is usually emaciated and icteric, and the blood is anaemic. A characteristic lesion in cattle which have died from an acute disease is severe intravascular clotting (Blood et al., 1979). In the cerebral form there is perivascular, perineuronal and interstitial oedema throughout the brain and spinal cord (Soulsby, 1978). According to Gibbons (1963), Burner and Gillespie (1973), Belschner (1974), Hall (1977) and Soulsby (1978), oedema often occurs in the subcutaneous tissue of the ventral part of the body, and the fatty tissue is yellow and gelatinous around the kidneys. Belschner (1974), stated that patches of congestion in varying amounts are present along the intestinal tract, and the blood is thin and watery (West, 1979).
I. ECONOMIC LOSS

With a rapidly increasing world population, the food needs of humans will be critical. Accordingly, diseases that affect domestic animals must of necessity be studied, understood, and controlled. Piroplasms that can be lethal to cattle have a worldwide distribution. For example, Babesia bigemina (Farmer, 1980), although no longer present in the United States, infects cattle in Africa, Australia, Europe, and South America.

Piroplasms are important economically because of their pathogenicity. Death or loss of productivity in bovine herd is characteristic of babesiosis. Infected animals fail to eat and suffer from severe anaemia. Death usually results from kidney damage and a rapid accumulation of toxic by-products. Because of economic impact of Babesia on cattle industry of the world, considerable money have been allocated towards research to produce pharmacological relief (Farmer, 1980).

Serous economic loss in northern Australia, mainly through deaths of cattle from the disease, loss of condition in animals recovering from an acute attack, loss of milk production in dairy cattle (Seddon and Albiston, 1966), and the condemnation of carcasses at abattoirs. In addition the cost of immunization, and the treatment of clinically affected animals impose an additional burden on the stock-owners and indirectly
on the country. The losses caused by babesiosis occur through failure to apply effective methods of immunization and treatment that are available. Mortality, production losses, quarantine, and other costs of controlling the spread of babesiosis, opportunity loss, and loss of markets for live grade or pedigree (Ristic and McIntyre, 1981), are the impact of babesiosis on development.

The economic analysis in the United States of America gives some figures that are indicative of the importance of babesiosis. The study concludes that once ticks and babesiosis established in the endemic areas of the United States, annual losses of US$500 million which was all attributed to eradication of the tick and babesiosis. While the Australian figures are derived from a study (Anon, 1975 in Ristic and McIntyre, 1981) in Queensland and New South Wales, the total estimated annual losses attributed to ticks, tick-borne disease, and their control amount to A$5.2 (US$7.8) and A$5.1 per head of cattle in the tick-infested areas of Queensland and New South Wales respectively.

In Mexico, Beltran (1975 in Ristic and McIntyre, 1981) reported that of 3587 million pesos lost annually because of ticks and tick-borne diseases, only 6.3% is a result of death, 83.6%, 8.5, and 1.6% attributed to loss of meat production, milk production, and hides respectively. In the developing countries, it is
difficult to obtain the actual figures because of limited records available to estimate the probable economic loss. However, it would probably be much greater economic loss caused by babesiosis in many Latin American countries and in many developing countries where *Babesia bigemina* is present (Ristic and McIntyre, 1981).

J. TREATMENT AND CONTROL

Trypan blue is probably the first specific drug used successfully to treat *Babesia bigemina* infections (Weinman and Ristic, 1968 and Ristic and Kreier, 1981). Intravenously injection of trypan blue at the rate 2-3 mg / Kg effectively eliminated *B. bigemina* (Ristic and Kreier, 1981). The drug usually produces discoloration of the animal flesh (Jones *et al.*, 1977), and in view of availability of new, more effective drugs, it is used less frequently.

Acaprin is the most prominent, is very effective against *B. bigemina* at the rate of 1 mg / Kg given subcutaneously (Ristic and McIntyre, 1981), and is the most widely used and is universally accepted as an efficient safe drug (Blood *et al.*, 1979).

Acridine derivatives such as Acriflavin, Flavin, Euflavin and Gonacrin are also effective, usually a 5% solution is administered intravenously in doses
of 15 to 20 ml per animal or 5 ml of a 5 % citrated solution intramuscularly (Soulsby, 1978).

Berenil is also very effective at the rate of 2-3 mg / Kg by deep intramuscular injection (Soulsby, 1978).

Since the natural transmission of *Babesia bigemina* is dependent on certain species of ticks, infection can be prevented by adequate tick control measures which keep animals from tick infection. This can be done by the regular dipping of cattle (Davis and Anderson, 1971, Jones et al., 1977 and Soulsby, 1978). Other measures are the immunization of susceptible stock; treatment of infected animals; and the control of stock movements (Hall, 1977). Control of infection may be accomplished by artificial premunition of young or introduced stock. This procedure may also be used to prevent or control outbreaks in marginal zones where ticks infection of stock varies considerably depending on climate condition (Weinman and Ristic, 1968).
Babesia bigemina is an intraerythrocytic parasite under the class Sporozoa and genus Babesia, and is generally found in the warmer areas infecting a wide variety of ruminants, such as deer, water buffalo and zebu, in addition to cattle; measuring 4 - 5 microns long by 1.5 - 2.5 microns wide. Diagnosis of B. bigemina infection is based on clinical signs of fever, hemoglobinuria, anaemia and icterus, and confirmed by the detection of parasites in the peripheral blood. It can also be diagnosed from autopsy or necropsy.

Transmission of B. bigemina is effected and initiated with the introduction of sporozoites into the blood through the bite of infected tick. There are also other possible modes of infection such as transference of parasitaemia blood through the agency of biting flies or unsterilised surgical instruments, by parenteral inoculation with blood. The pathogenesis of B. bigemina is considered as a highly pathogenic disease and may cause heavy mortality in susceptible stock due to the destruction of red blood. Exit of B. bigemina from infected cattle erythrocytes, two or more parasite-associated proteolytic enzymes are released into the plasma. These enzymes are ultimately responsible for the several pathologic and clinical signs of anaemia and icterus.

On necropsy, hyperaemic spots may be observed in the
III. CONCLUSION.

*Babesia bigemina* is an intraerythrocytic parasite under the class Sporozoa and genus *Babesia*, and is generally found in the warmer areas infecting a wide variety of ruminants, such as deer, water buffalo and zebu, in addition to cattle, measuring 4-5 microns long by 1.5-2.5 microns wide. Diagnosis of *B. bigemina* infection is based on clinical signs of fever, hemoglobinuria, anaemia and icterus, and confirmed by the detection of parasites in the peripheral blood. It can also be diagnosed from autopsy or necropsy.

Transmission of *B. bigemina* is effected and initiated with the introduction of sporozoites into the blood through the bite of infected tick. There are also other possible modes of infection such as transference of parasitaemia blood through the agency of biting flies or unsterilised surgical instruments, by parenteral inoculation with blood. The pathogenesis of *B. bigemina* is considered as a highly pathogenic disease and may cause heavy mortality in susceptible stock due to the destruction of red blood. Exit of *B. bigemina* from infected cattle erythrocytes, two or more parasite-associated proteolytic enzymes are released into the plasma. These enzymes are ultimately responsible for the several pathologic and clinical signs of anaemia and icterus.

On necropsy, hyperaemic spots may be observed in the
omentum, and the spleen, liver, lungs and kidneys are enlarged, and the bladder is distended with thick granular bile. The pericardium contains some blood-stained exudate and petechial haemorrhagic under the epicardium and endocardium. Death and the loss of productivity account for the economic loss due to the pathogenicity of the *B. bigemina* parasites. Acaprin at the rate of 1 mg / Kg administered subcutaneously and Acridine derivatives usually 5% solution given intravenously or intramuscular are the most prominent and effective against *B. bigemina*. Berenil is also very effective. Control efforts include control of the tick vectors, immunization of susceptible stock, treatment of infected animals and the control of stock movements.
REFERENCES


