

**INCIDENCE OF THEILERIOSIS AND CLINICAL TRIAL
ON THE EFFICACY OF CERTAIN ANTITHEILERIAL
DRUGS WITH PARTICULAR REFERENCE TO
BUPARVAQUONE (BW 720C)**

BY
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**THESIS SUBMITTED TO THE
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
MASTER OF VETERINARY SCIENCE
(IN THE MAJOR FIELD OF MEDICINE)**



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SEPTEMBER, 1992**

CERTIFICATE

Mr. T. P. Manoj Kumar has satisfactorily prosecuted the course of research and that the thesis entitled "Incidence of theileriosis and clinical trial on the efficacy of certain anti-theilerial drugs with particular reference to Buparvaquone (BW 720 C)" submitted is the result of original research work and of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part there of has not been previously submitted by him for a degree of any University.



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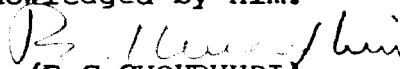
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This is to certify that the thesis entitled "Incidence of theileriosis and clinical trial on the efficacy of certain antitheilerial drugs with particular reference to Buparvaquone (BW 720 C)" submitted in partial fulfilment of the requirements for the degree of MASTER OF VETERINARY SCIENCE of the Andhra Pradesh Agricultural University, Hyderabad is a record of the bonafide research work carried out by Mr.T.P.MANOJ KUMAR under my guidance and supervision. The subject of thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma or has been published. Published part has been fully acknowledged. All the assistance and help received during the course of the investigation has been duly acknowledged by him.

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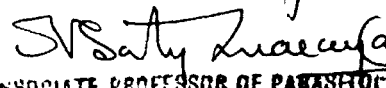
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It gives me a great pleasure to acknowledge my thanks to Dr.P.C.Choudhuri, Professor and Head, Department of Medicine for his encouragement, valuable suggestions, inspiration of ideas and guidance as the Chairman of the Advisory Committee.

I am highly thankful to the members of my advisory committee Dr.P.Rama Rao, Professor and Head, Department of Pathology, Dr.N.Satyanarayanacharyulu, Associate Professor of Parasitology and Dr.P.A.Hamza, Assistant Professor of Medicine, College of Veterinary Science, Tirupati.

I thank the departmental staff Dr.J.S.Reddy, Dr.P.S.Karunanidhi, Dr.N.A.Singari, Dr.N.Syamasundar, Dr.D.S.Tirumala Rao, Dr.K.Nalini Kumari and Dr.K. Mouli Krishna for their help and cooperation.

I wish to express my thanks to Dr.D.Venkatasubbaiah, Assistant Director(AH), Poly Clinic, Chittoor for providing the working facilities and thanks due to Dr.R.Sudhakar, Dr.A.R.Mohan Reddy, Dr.G.Padmavathi, Dr.P.V.Chari, Dr.A.Ramachandraiah and Dr.B.Peddaswamy, Veterinary Assistant Surgeons for their kind help while I was in Chittoor.

I am very much grateful to Dr.D.Satyaprasad, Assistant Director, Indo-Swiss Project, Visakhapatnam and Dr.N.Karunakar, Veterinary Assistant Surgeon, LATC, Visakhapatnam for their whole hearted support and help rendered in collecting of data.

My thanks are due to Dr.Sreeram Murthy, Senior Scientist and Dr.K.Babu Rao, Assistant Research Officer, Cattle farm, Lam, Guntur for providing the patient records.

I am grateful to Dr.M.Ramanarayana Reddy, Clinical Registrar, City Veterinary Hospital, Tirupati for his cooperation and help.

I wish to place on record my feelings, heart felt affection to my friends, colleagues, seniors and well wishers Dr.T.R.K.Prasad, Dr.Md.Arif, Dr.K.Venkata Rao, Dr.K.Mongeshwara Rao, Dr.M.Kishore, Dr.K.Rajasekhar, Dr.P.Ratnasree, Dr.S.Venkateswarulu, Dr.Y.V.Ramana, Dr.K.Sivaji, Dr.S.Subba Raja, Dr.C.Venkateswara Rao, Dr.R.Chinnalah, Dr.B.Ganapathi Rao, Dr.K.Gunasekhar Pillai, Dr.M.Venkateswarlu, Dr.V.Rushiprasad, Dr.S. Yathiraj, Dr.D.V.Satish, Dr.L.Hanuma Reddy, Dr.Laxmi Rani, Dr.N.Jagath Srinu, Smt.Vagdevi and Dr.J.Ratnakar for their encouragement and help given to me.

I heartly express my earnest gratitude to my beloved parents Shri Prasada Rao and Smt.Manoharamma for their lasting love, care and encouragement in pursuit of my studies as well as my life.

I hereby acknowledge my brothers Sunil, Anil and cousins Sudha, Sandhya for their affection.

At last it will be incomplete if I say no thanks to Mr.Suryanarayana and Mr.Chengalaih, Attenders who made their contribution for my research work. My appreciations due to Mr.K.Koteswaraiiah, U.D.Steno for his excellent typing work.

Last but not least from the inner depth of heart I give all glory and praises to the Almighty God for this work has been accomplished by his ever lasting mercy and abundant companion.


(T.P.MANOJ KUMAR)

In the Oxyvet LA plus Lariago treated group 3 of the 6 treated animals (50%) survived and were free of parasitaemia in one animal on the 1st day after treatment and all the animals became free of theileria 7th day onwards. Clinical recovery in this group observed 8-11 days of post treatment.

CHAPTER V

5. DISCUSSION

Theileriosis is a tick transmitted haemoprotozoan disease of cattle, which causes heavy mortality in the tropical countries. The total loss in India due to this disease has not been calculated. However, the annual loss in the state of Orissa was estimated as 8.21 crores (Satpathy and Pradhan, 1991). The incidence of this disease has been reported from various states of India as 53.6% in crossbreds in Karnataka (Sastry et al. 1981), 20.6% in Haryana (Yadav et al. 1985), 20.45% in crossbreds and 4.75% in indigenous cattle at Uttar Pradesh (Mallick et al. 1986) and 27.8% in Bihar (Sinha and Verma 1986). However, there is no report on the incidence of this disease in Andhra Pradesh though the disease occurs in various parts of the state for the past several years. Therefore, the present work was taken up to study the incidence in few selected Veterinary hospitals and livestock farms of Andhra Pradesh. In order to work out the incidence in hospitals the records pertaining to the ailing animals presented for treatment were scrutinised to find out the incidence of theileriosis. For study of the incidence in organised farms the percentage of positive cases as against

the total cattle population present in the farm during the particular year was taken into account.

The four clinics i.e., Veterinary Polyclinic, Chittoor; College Clinic, Tirupati; City Veterinary Hospital, Tirupati and Ambulatory Clinic, Thondawada and the organised farms like Cattle farm, Lam at Guntur and Indo-Swiss Project at Visakhapatnam were chosen since at these institutions there is good and adequate data recording system, availability of old case records and availability of adequate facilities for diagnosis of theileriosis.

The overall average incidence of theileriosis in various hospitals during the years 1986 to 1991 was 0.95% in relation to total number of white cattle presented for treatment. The incidence of theileriosis obtained in the present study is not in conformity with that reported by Mohanthy *et al.* (1990) 4.6%, which were moderately higher (4.6%) than that observed in the present study. Such variations may be due to difference in the density of crossbred livestock and vector population, differ in geoclimatic condition, percentage of exotic germplasm in native crossbred cattle, varied managerial and hygienic practices, prevalence of infected vector population and difference in the sample size.

The percent incidence of theileriosis was 33.65% by serosurvey in 410 crossbred and native cattle screened by Venkataraman et al. (1984) while Pradhan et al. (1991) reported the incidence to be 58% when they examined 1872 serum samples of cattle. The percent incidence by serological survey is generally much higher than the actual prevalence of clinical disease since the seropositive cases could be the active cases, convalescents, recovered are even carrier cattle. The incidence based on detection of positive cases by blood smear examination actually indicates the number of active cases alone obviously giving a true picture of the disease incidence which is far less than the serosurvey figures even in the same population.

Mallick et al. (1987) reported that 4.72% of indigenous and 20-45% of crossbred cattle infected were being affected with T.annulata when blood smears were taken from febrile cases which is almost in agreement with the present findings of 2% and 20.83% with relation to the indigenous cattle and crossbred cattle with pyrexia respectively among ailing animals.

The overall average incidence of theileriosis in both organised farms during the years 1986-91 was 4.56% and 11.17% with relation to average number of white

cattle and crossbred cattle present in the farms. Similar observations were recorded by Bansal et al. (1987) in U.P. where the incidence was 7 to 15%, while Shaw (1989) recorded 1.4% in cattle farms of Kashmir Valley. A higher incidence of theileriosis was recorded by Matikashvili et al. (1978) and Varshney (1991) which could be due to difference in sample size distribution of exotic and crossbred population and the low vector population in certain areas such as Kashmir valley. Perusal of table 9 indicates that among 4 hospitals only Veterinary Polyclinic, Chittoor recorded the highest incidence of 1.71%. While the lowest incidence of 0.09% was noted at City Veterinary Hospital, Tirupati with relation to the total number of white cattle attended for treatment. The higher incidence at the former centre might be due to the fact Chittoor is one of the few areas of A.P. having higher density of crossbred cattle. The comparatively lower incidence in City Veterinary Hospital, Tirupati due to the low density of crossbred population in this area and the inherently better resistance of indigenous cattle to withstand theileriosis.

Yearwise analysis of data pertaining to various hospitals on the incidence with relation to total

number of white cattle did not reveal wide variations from the year 1986 to 1991. The least incidence of 0.48% was recorded in the year 1986 and the highest 1.7% in 1991.

In the two organised farms there was no incidence of theileriosis in 1991. The highest incidence of theileriosis was 98.63% in 1987 in Cattle farm, Lam when the disease occurred in the form of a severe outbreak. During the same year the incidence in Indo-Swiss Project, Visakhapatnam was also comparatively higher i.e., 55.43% as against other years. Since this year all the animals were immunised with the vaccine i.e., Raksha Vac 'T' in both the farms, the incidence lowered in ISP and was not recorded at Lam during 1988. This could be due to the protection afforded by the vaccination and also regular spraying of insecticides like Cythion, Malathion, Nuvan and Neemguard at fortnightly interval in the sheds and on the livestock at appropriate concentrations in both the farms. Again during 1989 there was a spurt in the incidence i.e., 43.67% at Lam but it was nil at ISP. During the subsequent years the incidence was almost negligible to nil in both the farms which could be due to the annual immunisation build up of herd immunity and regular spraying of insecticides.

In the present study the highest incidence was recorded during the month of September (1.28%) followed by July (1.12%). The incidence was lowest during the month of August (0.68%) with relation to white cattle presented for treatment in the hospitals. These findings are in agreement with the earlier reports of Rao et al. (1986) and Mallick et al. (1987) who recorded most clinical cases during May and September in A.P. and June to October respectively. Sinha and Verma (1991) also reported highest incidence in July (34.59%) as recorded in the present study.

In the Farms the highest incidence of theileriosis was recorded during the September (1.80%) and least during January and March (0.0%). These findings are agreement with those reported by Sharma and Gautam (1977) as highest incidence recorded during hot and humid months. This may be due to higher vector activity and stress on livestock due to hot and humid weather.

Analysis of data on percentage of theileriosis in relation to season in hospitals (Table 17 and Figure 5) did not indicate much variation. However, during rainy season the incidence of theileriosis was highest (1.01%) as compared to winter season which recorded the lowest incidence (0.75%) in relation to white cattle attended for treatment.

In the farms also the pattern of seasonal occurrence was observed to be similar the incidence being 25.42% during rainy season lowest during winter with 8.62% in relation to average white cattle present in the farms. The present findings are in conformity with those of by Sinha and Verma (1991) who reported highest incidence during monsoon (29.20%) and least in winter (9.79%) season during which the vector population may be comparatively less.

Breedwise distribution of theileriosis positive cases indicated that minimum incidence in indigenous cattle (only 5.42%) attending hospital while none in the farms were affected. Among the indigenous cattle cows are mostly susceptible (3.22%) followed by calves 1.36% while bulls/oxen were least susceptible (0.85%). In the hospitals a total of (10.85%) calves were affected among theileria positive cases which includes indigenous calves (1.36%) and crossbred calves (9.46%). The present findings are nearly in conformity with those of Sharma et al. (1981) who reported incidence of theileriosis in calves at H.A.U., Hissar as 12.30%. However, Venkataraman et al. (1984) reported 22.22% and 20.0% in below 1 year age in exotic and indigenous cattle respectively. These variations may be due to number of animals screened for theileria and difference in

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Year of Submission : 1992

ABSTRACT

The overall incidence of theileriosis among cattle presented for treatment at the four clinics, i.e., Veterinary Polyclinic, Chittoor; City Veterinary Hospital, Tirupati; College Clinic, Tirupati and Ambulatory Clinic, Thondawada during the years 1986-1991 was 0.95%, 2.39%, 2.0%, 20.88%, and 13.79% with respect to total number of white cattle, crossbred cattle, indigenous cattle with pyrexia, crossbred cattle with pyrexia and white cattle with pyrexia respectively. In the two farms i.e., Cattle farm, Lam, Guntur and Indo-Swiss Project, Visakhapatnam the incidence of theileriosis in indigenous cattle was nil. While in crossbred population it was 11.17% giving

methodology while calculating the percentage of theileriosis. Analysis of cumulative incidence of all the hospitals and farms put together indicated that among the positive cases the percentage of theileriosis in crossbred cattle was 96.15% and in indigenous cattle it was 3.85%. These findings are not in agreement with those of Sastry et al. (1981) with 56.7% in pure exotic breeds, 45% in crossbred and 25% in indigenous cattle. Mallick et al. (1987) reported 4.72% in indigenous and 20-40% in crossbred. These variations probably could be due to variation in susceptibility of different breeds, sample size and different methodology used for diagnosis of theileriosis.

Breedwise analysis of the data indicate the incidence in Jersey cows to be 70.16% against 12.64% in H F crosses indicating a higher susceptibility of Jersey animals. Another important observation from the present study is probably the Ongole cattle are more resistant as compared to other indigenous cattle. Results of this study with respect to farms lends a very strong support for the high susceptibility of the crossbred as compared to high innate resistance of the indigenous Ongole cattle as both the breeds of animals were almost equal in number i.e., almost 100 to 180 each were being maintained in the same farm (Cattle farm, Lam) under similar managerial

nutritional and healthy control practices. During the 1987 outbreak when 98.63% of crossbred cattle were affected not a single Ongole cattle was affected with theileriosis in the same farm. As such it can be concluded that Ongole cattle are quite resistant to theileriosis.

For comparison of the pretreatment and post treatment clinico-biochemical and haematological values of theileria affected cattle and the fifteen animals of the control group were chosen from the same area. These animals were healthy, alert and were negative for blood protozoa. The mean temperature, pulse, respiration rates and rumen motility recorded are well within the normal range as reported by Udaysankar et al. (1986), Subbaraja et al. (1989); and Venkateswarulu et al. (1990).

The PCV, haemoglobin, TEC and TLC values are recorded as $30.8 \pm 1.01\%$, 10.70 ± 0.34 g%, 5.24 ± 0.24 mill/cmm and $8.84 \pm 0.26 \times 10^3$ /cmm respectively. The haemoglobin and TLC values obtained in the present study are in conformity with the values reported by Baumgertner (1979) and Haider and Siddique (1989). While the TEC values are similar to the values observed by Aleucar (1972), Danov (1977) and Baumgertner (1979).

In the present study the biochemical values of blood glucose and serum iron reported as 47.72 ± 9.33 mg%

and 150.83 ± 6.83 ug% respectively. The blood glucose values are nearly coinciding with values reported by Sethuraman and Rathor (1979) and Venkateswarulu et al. (1990). The serum iron values reported by Brown (1966) with range of 20 to 180 ug%, Sarror (1955) with range of 50-240 ug%, Pandy et al. (1982) with 158.21 ug% which are similar to the observations made in present study.

The clinical symptoms of theileriosis recorded during the present investigations like anorexia, weakness, swelling of prescapular lymphnodes, fever and anaemia are well established and also in conformity with those reported by earlier workers (Gautam et al., 1970; Sharma and Gautam, 1973; Gill et al., 1977 and Suresh et al., 1986). The symptoms like reduction in milk yield in lactating animals could be due to fever, general weakness and anaemia such symptoms were also recorded by Sharma and Gautam (1973), Prasanna Kumar et al., (1988), Dumanli and Ciftci (1988) and Unsuren et al. (1988). Nervous symptoms such as circling movements, muscular twitching, paddling movements of legs, pressing of head against fixed objects, which were recorded in experimental cases (Sharma and Gautam, 1973; Srivastava and Sharma, 1976) could not be seen in any case during the present study. The symptoms like cough and

bilateral serous nasal discharges observed during the present trial were correlating with the symptoms reported by the Karunanidhi et al. (1982), Mallick (1991) and could be mostly due to secondary bacterial infection. Other occasionally encountered symptoms like skin nodules, utricularial lesions reported by Karunanidhi et al. (1982), Manikkam et al. (1984) and Sudan et al. (1992) in theileria infected animals were not seen in any case during the present investigation.

In theileria affected animals belonging to both the groups the mean values of temperature, pulse and respirations were $105.11 \pm 0.47^{\circ}\text{F}$, $75.57 \pm 4.72/\text{min.}$ and $29.43 \pm 1.49/\text{min.}$ and $105.47 \pm 0.37^{\circ}\text{F}$, $76.67 \pm 3.8/\text{min.}$ and $32.67 \pm 1.6/\text{min.}$ respectively for group I and group II. All the above values of both the groups were significantly higher ($P < 0.01$) as compared to the corresponding values in the control group. There was a significant decrease ($P < 0.01$) in the rumen motility in both the groups. Similar observations have been reported by the earlier workers (Sharma and Gautam, 1973; Gill et al., 1971; Bulkan et al., 1979; Karunanidhi et al., 1982; Suresh et al., 1986 and Prasannakumar et al., 1988).

In animals of group I the pretreatment values of PCV, haemoglobin, TEC, blood glucose, serum iron signifi-

cantly decreased ($P < 0.01$) when compared to healthy control group where as in group II only PCV, haemoglobin, blood glucose and serum iron values decreased significantly ($P < 0.01$). In the later group, total erythrocyte count ($P < 0.05$) decreased significantly. In both the groups the total leucocyte count did not show any significant difference. The findings of the present study are in close agreement with the findings of Sharma and Mishra (1990) who have recorded 40.3% fall in PCV. Dhar and Gautam (1979) and Sharma et al. (1980) observed a gradual fall in PCV in experimental theileria infection, on the other hand Shastry et al. (1985) indicated that decrease in PCV was directly proportional to the increase in percentage of parasitaemia. Dhar et al. (1990) observed decrease in PCV in the initial phase of T.annulata infection.

There was a significant decrease in haemoglobin in present study in theileria infected cattle of both the groups. This could be due to the increased destruction of RBC in excess of their production. Similar observations have been reported by Dhar and Gautam (1979), Shastry et al. (1985), Rhandhawa et al. (1990). Shukla and Sharma (1991) reported a gradual fall in haemoglobin until chronic phase of infection and concluded that the decline in haemoglobin is directly proportional to the increase in percentage of parasitaemia.

The decrease in erythrocyte count could be as a consequence to the penetration of erythrocytes by the merozoites and rapid removal of the infected erythrocytes by the spleen and liver (Oteng, 1964; Jeon et al., 1973; Ruprah, 1974, Dhar and Gautam, 1979 and Randhawa et al. 1990) while the gradual fall in TEC. observed by Sharma et al. (1980) in experimental cases. Besides the normal means of removal of erythrocytes evidence of increased erythrophagocytosis could be established by examination of the spleen impression smears (Gautam, 1982). In experimental cases of T.annulata infection in calves there was a gradual decrease in RBC counts until the chronic phase of the disease during which clinical anaemia with maximum fall in R B C count occurred after peak parasitaemia (Dhar and Gautam 1979). As different from this Laiblin (1978) observed erythrocytopenia, thrombocytopenia before the appearance of erythrocytic form in circulation and considered that the animals had an aplastic anaemia. Similar observations were recorded in the present study as there was a significant decrease in the TEC of group I and II.

The average leucocyte count in animals of group I and group II before treatment was $7.98 \pm 1.54 \times 10^3$ /cmm and $7.33 \pm 1.31 \times 10^3$ /cmm which was slightly lower than the control value of $8.84 \pm 0.26 \times 10^3$ /cmm. Sharma and

Gautam (1977) reported the TLC to ranges from 3 to 5 thousands/cmm in 686 cases of experimentally induced and acute form of theileriosis. These values are slightly less than the present observation. Several other workers i.e., Dumanli (1987) and Sharma (1979) have reported decrease in leucocyte count in experimental theileriosis, while Randhawa et al. (1990) recorded similar observations in a mixed infection of theileriosis and anaplasmosis. However, Banerjee et al. (1988) recorded a moderate leucocytosis in early phase of clinical cases of theileriosis.

In the animals of group I and II there was significant decline in ($P < 0.01$) serum iron values i.e., 85.88 ± 9.95 ug% and 96.71 ± 7.29 ug% respectively before treatment. Though clinically anaemia has been reported as a consistent symptoms by several workers along with decrease in TEC, PCV, and Hb values but the information on the serum iron values in theileria infected cattle is very meagre. Sinha (1991) observed a significant decrease ($P < 0.05$) in iron values in haemoprotozoan infections like theileriosis, anaplasmosis and trypanosomiasis. In anaemic cattle various workers like Wintrobe (1933) reported 100 ug% serum iron. Frank et al. (1970) reported 80.30 ± 27.23 ug% in diseased conditions. Kaneko (1980) described decline in serum iron values in iron deficiency anaemia, acute phase of inflammatory reaction and chronic inflammation.

As compared to various parasitic diseases like babesiosis in which there is haemolysis, haemoglobinuria, chronic parasitic infestation resulting in haemorrhagic anaemia, in theileriosis there is no loss of iron from the body to outside. Therefore, the observed decrease in serum iron could be due to erythrophagocytosis where by the release of iron from the phagocytes for reutilisation could be delayed.

Various authors like Bansal et al. (1977), Yadav and Gautam (1986) and Anantwar et al. (1986) observed hypoglycaemia in theileria infected cows and calves. Similar observations were recorded in the present investigation on blood glucose values before treatment in both the groups. This could be due to excess utilisation of glucose for high body temperature and a comparatively lower intake of feed due to partial loss of appetite.

Effective treatment of theileriosis remains a problem in tropical countries. Various drugs have been evolved from time to time but so far no drug has been shown to have 100% efficacy against theileriosis. However, recently a series of hydroxynapthoquinons (993c, parvaquone and BW 720c, buparvaquone) have been reported to give promising results as these are found to be effective both the schizogenic and erythrocytic stage of parasite. These drugs act by obstructing

electron transport chain. Initially parvaquone was recommended @ 20 mg/kg body weight but MacHardy et al. (1985) demonstrated that buparvaquone probably due to its greater resistance to metabolic degradation is much more effective than parvaquone. Therefore, in the current study buparvaquone (M/S Beecham Animal Health, UK) containing 2 hydroxy-3 (Trans-4-butyrchyco-hexy) methyl 1-4 naphthoquinone which contain 50 mg of the above compound per milli litre was given at the rate of 1 ml/20 kg body weight i.e., 2.5 kg/kg body weight to the 7 theileria infected crossbred cows. Of the 7 clinical cases treated 2 animals died on 4th and 6th day of post treatment by manifesting typical symptoms of theileriosis. However, the remaining 5 cows showed considerable improvement in clinical symptoms, improvement in haematological and biochemical mean values after 12th, 20th day post treatment when compared with the values of before treatment. The temperature, respiration ($P < 0.01$) and pulse mean values significantly decreased ($P < 0.05$) and improvement in rumen motility ($P < 0.01$) was observed on 12th day. A further significant decrease ($P < 0.01$) in temperature, respiration rate and pulse ($P < 0.05$) was observed on 20th day post treatment while rumen motility rate improved significantly ($P < 0.01$) with a mean of $2 \pm 0.00/2$ min.

The slight increase in respiration rate could be due to comparatively low haemoglobin level in the recovered animals.

The Hb and PCV though increased a little but could not reach the comparable limits of control animals. This could be due to the fact that throughout the treatment supportive therapy like liver extract, iron-dextran etc. were not given in order to avoid the difficulty of ruling out the efficacy of supportive therapy from that of the main drugs though in routine clinical practice these are necessary to be given to improve the low Hb, PCV, TEC and serum iron and alleviate anaemia.

Among the haematological parameters like PCV, Hb, TEC, TLC there was insignificant improvement observed on 12th day. However, only TEC significantly ($P < 0.01$) improved on 20th day of post treatment.

Similar to the haematological observation no significant improvement could be observed in the biochemical parameters like blood glucose, serum iron by the 12th day whereas on day 20th there was significant improvement ($P < 0.05$) in blood glucose and serum iron values only. All the surviving animals improved in general condition and milk yield improved in lactating animals.

an average of 4.56% in total white cattle. This disease occurred in the form of outbreak during 1987 at both the farms affecting 74.55% of crossbred population subsequently due to regular vaccination and spray of insecticides the incidence was nil at ISP, Visakhapatnam for 1989 to 1991 and at Lam for 1991.

Both at the hospitals and farms the highest incidence of theileriosis observed during the month of September. Seasonwise analysis of data indicated the least and the highest incidence during winter and rainy seasons respectively. Among the 831 theileria positive cases in farms and hospitals during 1986 to 1991 about 96.15% were crossbred, while only 3.85% were indigenous cattle. The later was recorded only at Veterinary Polyclinic, Chittoor. Breedwise incidence indicated that Jersey crosses were more susceptible than HF and interse crosses.

For the therapeutic trial 13 clinical cases of theileriosis were divided into 2 groups. The group I comprised of 7 cows which were treated with Buparvaquone @ 2.5 mg/kg body weight once. All the 6 cows of group II were treated with Oxyvet LA @ 20 mg/kg body weight as single i/m injection along with Lariago @ 15 ml, 10 ml, 5 ml on three consecutive days i.e.,

Though the parasitaemia waned by about the 7th day and eventhough some clinical improvement was observed there was no improvement in the Hb, PCV, serum iron by the 12th day which may be due to fact that the animals were treated only with antitheilerial drug without any supportive treatment such as iron, liver extracts etc. Dhar et al. (1989) observed no fall in Hb, PCV when drug was given prior to the inoculation of theileria in crossbred cattle experimentally as immunoprophylaxis. However, under such controlled experimental infection giving drug prior to establishment of infection could check the multiplication, lower the rate of invasion of erythrocytes by merozoites and their removal there by not markedly affecting the haemoglobin and PCV values. However, in the present study as the cases were presented by the farmers for treatment in the advanced stage of disease (i.e., the protozoa already established well in the animal body) hence even the animals recovered clinically the Hb, PCV could not improve significantly even after 20th day post treatment. Dhar et al. (1990) found Hb and PCV to decrease initially after theilerial infection which rapidly returned to pretreatment level. Banerjee et al. (1988) recorded gradual improvement in PCV, Hb, TEC values after 30th day of post treatment and observed 100% recovery however in this trial along

with buparvaquone the authors used Vitamin B Complex, antihistamin~~s~~, antipyretics, parentrally and haematinics orally which could have brought about the improvement.

In the present study the shedding of parasite was observed on the second day in few and all animals became negative on day 7 which is almost agreeable with the findings of Dhar et al. (1987) who observed shedding of parasite starting on 6th day and ended after 15th day in experimental cases. This variation may be due to difference in the percent of parasitaemia, variation in the strain of theileria and the stage of the disease at which it was presented for treatment at the clinics by the farmers.

During this investigation 5 out of 7 animals of group I which were treated with buparvaquone survived giving an overall efficacy of 71.4% for this drug. Sastry (1989) reported 58.8% efficacy, while Banerjee et al. (1988), MacHardy et al. (1985) reported 100% efficacy. However, Banerjee et al. (1988) had given buparvaquone in 2 doses with supportive therapy such as liver extract, paracetamol, haematinic etc. hence the recovery rate could have been high as compared to a single dose of buparvaquone without supportive

therapy used in the present study. Dhar et al. (1987), in artificial and natural infection of T.annulata in cattle have also shown recovery rate of 70-100% with buparvaquone. Hashemi Fesharki (1991) reported 88.7% efficacy in clinical trial. The efficacy rates mostly depends upon the stage of infection, variation in the percent of parasitaemia, difference in the theileria strain and the percentage of exotic germ plasm in the affected cattle, besides the use of supportive therapy.

In group II six clinical cases were treated with oxyvet LA (Sarabhai chemicals, Baroda) @ 20 mg/kg body weight as a deep 1/m and Lariago (IPCA laboratories Ltd., Bombay) @ 15 ml, 10 ml, 5 ml on three consecutive days and observed the mean temperature of 4 surviving cows to have significantly decreased ($P < 0.01$) on 12th day post treatment. There was a significant improvement in mean rumen motility. On the 20th day the mean temperature and respiration of 3 surviving cows significantly ($P < 0.01$) decreased and rumen motility significantly ($P < 0.01$) increased when compared to pre treatment mean values. There are many reports on the use of long acting oxytetracycline but no reports are accessible on its combination with chloroquine as in the present study though this schedule is being used in some clinics. However, individual drugs i.e., oxytetracycline LA or nivaquine have been tried by number of

workers. Hedge et al. (1971) reported complete cure within 6-10 days when nivaquine was given in the initial stages of the infection. Rao et al. (1973) observed that after treatment with Nivaquine given 20 ml in combination of Achromycin 500 mg/animal the stained blood smears became free of infection on the seventh day of therapy in all the animals. Khanna et al. (1980) identified oxyvet LA with rolitetracycline to give better response than monectone.

On day 12th, 20th day post treatment the surviving cow's mean Hb, TEC, and serum iron values were significantly ($P < 0.01$) higher. At the end of drug trial three animals survived giving the efficacy of treatment as 50%. The shedding of protozoa from the blood started in surviving cows on day 5 and all the animals were free of infection on the 6th day.

In the present study the 20th day post treatment mean values of all the parameters of both groups (I & II) related to clinical, haematological and biochemical parameters are comparable with the mean values of control group (Table 29). There was no significant difference in ($P < 0.01$) temperature, pulse, respiration, rumen motility, TEC and serum iron values indicating

complete recovery of the treated animals. While in group II there was no significant difference observed even in PCV. However, in both groups haemoglobin, blood glucose values are shows significant difference ($P < 0.01$).

Based on the reduction of blood protozoa, number of animals found free of infection, alleviation of clinical symptoms the present study indicates that for treatment of clinical theileriosis buparvaquone is the drug of choice with a recovery rate of 71.4% as against 50.0% of recovery obtained by using oxyvet LA and Lariago combination.

CHAPTER VI

6. SUMMARY

An attempt was made to work out the incidence of theileriosis among bovines attending for treatment at various hospitals i.e., Veterinary Polyclinic, Chittoor; College Hospital, Tirupati; City Veterinary Hospital, Tirupati and Ambulatory Clinic, Thondawada and Dairy Farms like Cattle Farm, Lam, Guntur and Indo-Swiss Project, Visakhapatnam for the period from 1986-91 based on available records. Therapeutic trial was carried out on two groups of theileria affected cross-bred cattle with buparvaquone and Oxytetracycline (Long acting) along with chloroquine. The efficacy of therapy was determined by the percentage recovery and improvement in biochemical, haematological observations and clinical symptoms.

During this period total of 62,019 white cattle admitted for treatment in all the four clinics of which 590 cases were theileria positive giving an overall incidence of 0.95%. When the data were further split with respect to indigenous and crossbred cattle with and without fever and white cattle with fever the incidence was found to be 2.39%, 2.0%, 20.88% and 13.79% respectively.

Among the white cattle none of the indigenous cattle did suffer from theileriosis whereas the crossbred cattle had an incidence of 11.7%.

Yearwise analysis of the data from 1986 to 1991 revealed highest incidence of theileriosis in cattle farm Lam and ISP Visakhapatnam during the year 1987. No incidence of this disease could be recorded during 1989 to 1991 at ISP and 1991 at Cattle farm, Lam. The highest monthwise incidence recorded during September month as 1.25% and 1.8% among white cattle in the hospitals and Farms respectively. During rainy season the highest incidence observed in the hospitals (2.49%) and Farms (59.42%) in crossbred cattle. In the farms the incidence was found to be 4.56% and 12.6% in cattle farm Lam, Guntur, 4.59% and 9.36% in Indo-Swiss Project, Visakhapatnam with regard to white cattle and crossbred population.

Breedwise analysis of data indicated the incidence to be more in the Jersey cross cows 70.16% as compared to 12.64% HF and 3.37% in intersee crosses.

The therapeutic trial was conducted in 13 clinical cases of theileriosis by dividing into two groups. The first group consisted of 7 crossbred cows treated with Buparvaquone given @ 2.5 mg/kg body weight as single 1/m

injection. The remaining 6 animals in group II were treated with Oxyvet L A @ 20 mg/kg body weight as a single i/m injection along with Lariago at the rate of 15 ml, 10 ml, 5 ml on three consecutive days. Detailed clinical examination of the animals was conducted and symptoms were recorded. Blood and sera samples were collected before, 12 and 20 days after treatment for haematological and biochemical analysis. These values were compared with the average normal values of 15 healthy crossbred cattle of the control group.

The clinical symptoms observed included anorexia, enlargement of prescapular lymphnodes, weakness, pale anaemic conjunctival mucous membranes, reduction in milk yield in lactating animals, enteritis, cough and bilateral serous nasal discharges. Before commencement of treatment in animals of group I and II the temperature was $105.11 \pm 0.47^{\circ}\text{F}$ and $105.47 \pm 0.37^{\circ}\text{F}$, pulse $75.57 \pm 4.72/\text{min}$ and $73.67 \pm 3.84/\text{min}$, respiration $29.43 \pm 1.49/\text{min}$ and $32.6 \pm 1.6/\text{min}$ and rumen motility was $0.43 \pm 0.2/2 \text{ min}$ and $0.67 \pm 0.21/2 \text{ min}$. Compared to the values of control group there was a significant decrease in PCV $19.71 \pm 0.84\%$ and $22 \pm 1.03\%$, haemoglobin $5.93 \pm 0.32 \text{ g\%}$ and $6.17 \pm 0.33/\text{g\%}$, TEC $3.92 \pm 0.13 \text{ mill/cmm}$ and $4.16 \pm 0.12 \text{ mill/cmm}$, TLC $7.97 \pm 15 \times 10^3/\text{cmm}$ and $7.33 \pm 1.31 \times 10^3/\text{cmm}$.

There was also decrease in blood glucose and serum iron to 39.14 ± 0.93 mg% and 85.58 ± 9.95 ug% in animals of group I and 37.35 ± 1.25 mg% and 96.71 ± 7.29 ug% in group II respectively.

Of the seven animals treated with buparvaquone two died on 4th, 6th day of post treatment exhibiting typical symptoms of theileriosis. Alleviation of clinical symptoms like swelling of lymphnodes, pyrexia, cough observed with in the period of 3-10 days of post treatment, though two animals were free of parasitaemia on day 2 but it was only on day 7 onwards all the animals became negative for theileria in the stained blood film.

On the 20th day of post treatment there was a significant decrease in temperature, respiration ($P < 0.01$), pulse ($P < 0.05$) rate and significant improvement ($P < 0.01$) in rumen motility. There was a significant improvement in ($P < 0.01$) TEC, ($P < 0.05$) blood glucose and serum iron when compared to pretreatment values.

In the group II three animals died of theileriosis on day 4th, 6th, 13th days post treatment. The animals became negative for theileria in blood smears by the 7th day. But the remaining animals were bright, alert with improvement in general condition and milk yield in

lactating cows. On 20th day of post treatment the mean temperature, pulse, respiration and rumen motility of the 3 surviving cows were $101.0 \pm 0.4^{\circ}\text{F}$, 57.33 ± 0.60 min, $22 \pm 1.15/\text{min}$ and $2 \pm 0.00/2$ min respectively. The mean PCV, haemoglobin, TEC, TLC, blood glucose and serum iron were $26 \pm 1.15\%$, 6.67 ± 0.44 g%, 4.76 ± 0.11 mill/cmm, 7683.3 ± 338.29 , 42.28 ± 0.89 mg% and 125.52 ± 6.56 ug% respectively.

Though there was improvement in clinical symptoms haematological and biochemical finding on the 20th day in both the groups but from the recovery rate it can be concluded that buparvaquone is the drug of choice with a cure rate of 71.4% against 50% of recovery by Oxyvet LA and Lariago combination in the treatment of clinical theileriosis.

group II. The control group comprised of 15 apparently healthy animals.

The clinical symptoms observed in theileria infected cattle were anorexia, swelling of prescapular lymph-nodes, weakness, reduction in milk yield in lactating animals, enteritis, cough and bilateral nasal discharges. The mean values of the parameters before commencement of treatment in group I and II recorded significant increase in temperature, pulse and respiration rates, while the mean rumen motility, PCV, haemoglobin, TEC, blood glucose and serum iron values were significantly decreased when compared to control group.

Out of the 7 animals of group I two animals were died on 4th and 6th day after initiation of treatment. Though only two animals were free of parasitaemia on 2nd day post treatment. On 7th day onwards all the remain animals became free of protozoa. On 12th day of post treatment there was significant decrease in ($P < 0.01$) temperature, respiration and ($P < 0.05$) pulse rates. Rumen motility increased significantly ($P < 0.01$) when compared to before treatment values. There was further improvement in the above three observations by the 20th day of treatment. The TEC, blood glucose and serum iron values improved significantly by the 20th day. In this group all clinical symptoms were alleviated within 3-10 days of post treatment.

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In group I and II on 20th day post treatment when mean values compared with healthy control group there was no significant difference in temperature, pulse, respiration, rumen motility, TEC, and serum iron values indicating complete recovery of the treated animals. But in both groups haemoglobin and blood glucose showed significant difference ($P < 0.01$).

Based on the recovery rate, reduction in clinical symptoms and alleviation of haematological and biochemical changes from the findings of the present study indicate that treatment of clinical cases of theileriosis with buparvaquone is comparatively better giving a cure rate of 71.4% as compared to 50% in animals treated with Oxyvet LA and Lariago combination.

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LIST OF SYMBOLS AND ABBREVIATIONS

A.P	: Andhra Pradesh
	: At the rate of
B.Wt	: Body weight
°C	: Degree centigrade
Co	: Cobalt
Cu	: Copper
cm ³	: Cubic millimeter
dl	: decilitre
ELISA	: Enzyme linked immunosorbent assay
etc.	: Etcetra
°F	: Degree Fahrenheit
F ₁	: First generation
Fe	: iron
g	: gram
Hb	: Haemoglobin
HF	: Holstin-Friesian
h	: hours
i.e.,	: That is
IFAT	: Immunofluorescent Antibody Technique
ISP	: Indo-Swiss Project
i/m	: intramuscular
i/v	: intravenous
kg	: kilogram
LA	: Long acting

L : Litre
ug : microgram
mg : milligram
mill : millions
ml : milli litre
min : minute
no : number
PCV : Packed cell volume
/ : per
% : Percent
PI : Post infection
r.b.c : red blood corpuscle
S.E : Standard Error
TEC : Total erythrocyte count
TIBC : Total iron binding capacity
UIBC : Unsaturated iron binding capacity
UP : Uttar Pradesh
UK : United Kingdom
Viz. : Namely
VPC : Veterinary Poly Clinic

CHAPTER I

1. INTRODUCTION

Tick born diseases have long been identified as major obstacle to efficient livestock production in the tropics. Theileriosis is one such tick born haemoprotozoan disease which causes great economic loss to the farmer by incapacitating the animal resulting in decreased milk yield and productivity.

As a new strategy for boosting the milk production of the indigenous cattle, the Government of India has introduced crossbreeding programme utilizing exotic germplasm. As a result of this programme while the milk yielding capacity of the indigenous breeds of cattle was sufficiently increased but such animals become highly vulnerable for a number of infections in general and theileriosis in particular. The indigenous cattle are also comparatively resistant to tick bite where as these crossbred cattle are more susceptible tick infestation and thus the tick born diseases.

In India Theileriosis was detected in animals since early part of the 19th century as reported by Lingard during the year 1905 (Mohan, 1972). Subsequently Sen and Srinivasan (1937) reported about the

fatal termination in imported Friesian bulls and Indian crossbred cattle while Raghavachari (1944) considered theileriosis to be a serious menace to calves in India. This infection came into limelight only when Gautam et al. (1970, ...) recorded several cases of theileriosis in exotic cattle resulting in heavy mortality. Though the prevalence of this infection has been reported in indigenous cattle, the affected animals generally donot show clinical signs, but are a constant source of infection to the susceptible animals (Narasimhamurthy et al. 1970).

Two species of Theileria viz. T.annulata and T.mutans have been recognised serologically which affect the cattle population in India (Dhar and Gautam, 1977:).

Due to favourable climatic conditions the population of vector tick is very high in different parts of the country. At present no systematic tick eradication programmes are in operation. Majority of the animals suffer during summer and rainy seasons i.e., from May to October, though isolated cases may occur throughout the year. The seasonal incidence has been attributed to the higher activity of the vector tick during these months super imposed with stress of the prevailing hot and humid weather.

The serological survey conducted indicates its incidence to be from 20.45% in Uttar Pradesh, 20.6% in

Haryana, 27.8% in Bihar and to as high as 56.35% in Karnataka (Sastry et al. 1981, Syamsundar and Choudhuri, 1989). Among cases of theileriosis the incidence was reported to be 30% in calves in Tamil Nadu. Agewise the prevalence rate in young crossbred calves was 33.8%. Sastry et al. (1981) found a seroprevalence rate of 53.6% in cattle over 1 year of age, 36% in calves, 25% in indigenous breeds. However, the incidence of theileriosis in various parts of Andhra Pradesh has yet remains to be worked out though few reports are there on the occurrence of the disease in this state. Similarly the frequency of incidence of theileriosis with relation to season, month, breed, etc. remains to be worked out.

Chemotherapy of tropical theileriosis is still in the developing stage. About 200 drugs including amquinolines, folate antagonists, antibiotics, diazocompounds, dimidines, quinalones and inophores were tried for treating the disease. Recently a series of hydroxynaphthoquinones (993 C, parvaquone, and WB 720 C, Buparvaquone) have been developed and tried against experimental and natural infection of T.annulata and it was found effective on both the schizogonic and erythrocytic stages of parasites. MacHardy et al. (1985) demonstrated that Buparvaquone probably due to its greater resistance to

metabolic degradation was much more effective than parvaquone in its antitheilerial properties. Therefore the objectives of the present study will be;

1. To find out the incidence of theileriosis in some parts of A.P. based on the hospital records of cases treated in the college clinic, City Veterinary Hospital, Tirupati; Ambulatory Clinic, Thondawada and Veterinary Polyclinic, Chittoor.

2. To find out the incidence of Theileria in certain well maintained crossbred dairy farms such as cattle farm, Lam, Guntur and Indo-Swiss Project, Visakhapatnam.

3. To record clinical observations and haematological and biochemical changes in blood in few clinical cases of theileriosis.

4. To find out therapeutic efficacy of Buparvaquone as against long acting oxytetracycline along with chloroquine phosphate in clinical cases of theileriosis.

CHAPTER II

2. REVIEW OF LITERATURE

2.1 INCIDENCE OF THEILERIOSIS

Narasimhamurthy et al. (1968) reported a case of theileriosis in a Kerry X Punganur cow and successfully treated with three injections of Babesan in addition to supportive therapy.

Gautam et al. (1970) diagnosed Theileria annulata infection in four Danish red bulls, three Jersey bulls and a Holstin yearling with symptoms of pyrexia, swelling of superficial lymphnodes and satisfactorily treated the cases with intramuscular injections of diminazene aceturate (Berenil) at the dose rate of 10-15 mg per kg body weight. The authors observed that diminazene when given at a dose rate of below 7 mg/kg did not check the parasitaemia.

Mathur et al. (1971) recorded Theileriosis in five Jersey bulls and one of them was confirmed as an acute clinical case of Theileria annulata infection in which the number of infected erythrocytes increased with the period of illness and there was a relative increase in the percentage of rod shaped parasites in later stage of illness.

Sharma and Gautam (1971) carried out studies on advanced stages of Theileria annulata infection in Haryana and Sahiwal breeds of cattle and demonstrated the parasite in erythrocytes and the schizonts in the peripheral circulation and Koch's blue bodies in affected lymphnodes, liver and spleen but failed to treat the infection with Berenil (diminazine) and chlortetracycline combination.

Chhabra et al. (1972) reported theilerial infection in a buffalo in Punjab for the first time besides two Holstin-Friesian heifers and these animals responded well to treatment with Nivaquine and chloramphenical with glucose saline, tonics and haematinics.

Sharma and Gautam (1973) recorded a case of cerebral form of theileriosis due to Theileria annulata infection in a 17 day old Haryana calf with high fever, enlargement of superficial lymphnodes, severe anaemia, haemoglobinuria, jaundice and nervous symptoms in the terminal stages of disease.

Duttwanjang (1974) in his epidemiological surveys between 1972 and 1973 revealed very high theilerial infection rates from 40% to 100% in Korean cattle.

Rensburg (1976) reported 5 cases of bovine cerebral theileriosis with splenic intarction for the first time with macroscopically visible thrombosis of branches of the splenic vessels.

Prabhakar and Hiregovar (1977) observed an average of 56% incidence of the 1424 blood smears examined for theileria in six sheep farms in Karnataka. Out of these 70% sheep were exotic breeds, 64% were crossbreds and 52% were indigenous.

Sharma and Gautam (1977) diagnosed 686 cases of Theileria annulata infection, 114 were European breeds of cattle in Hissar during 1969-75 with acute form of disease. The clinical symptoms characteristic of the disease were petechial haemorrhages, haemorrhagic spots in perineal region and vaginal mucosa with abortion in pregnant animals. The authors also recorded 279 cases in indigenous calves with Inappetance as usual symptom. Another 293 cases of crossbred cattle affected with mixed infection of Anaplasma marginale and theileriosis. The disease was seasonal with most cases occurring during the hot humid months. Icterus, bilirubinuria, haemoglobinuria, cutaneous lesions and relapses of disease were reported in recovered animals.

Giles et al. (1978) observed bovine cerebral theileriosis in Masai cattle with neurological signs of circling, dysmetria and terminal semicomatose state with illness lasting for 5-12 days. Brain impression smears showed large number of schizonts in many fields.

Matikashvili et al. (1978) reported 37% of Theileria annulata infection in cattle of one farm at eastern Georgia. Usually carrier cattle and ticks were necessary for maintaining infections. These were present only in eastern Georgia.

Bulman et al. (1979) recorded an outbreak of tropical theileriosis in cattle due to stress. Four bulls out of the 7 shipped from a breeding farm in subtropical Jaldabad to Kabul (150 km west) suffered and introduced the infection.

Sharma et al. (1979) in their studies on incidence and control of theileriosis in Jersey cattle recorded that 51 of the 61 heifers, 6 out of 19 bulls and 3 out of 12 calves were infected with Theileria annulata. Of the affected animals four heifers and one calf died. Postmortem examination showed haemorrhages of the trachea, myocardium and endocardium,

oedema and hypostatic congestion in the lungs with enlarged prescapular lymphnodes and ulcers throughout the abomasal folds.

Sastry et al. (1981) screened 194 serum samples collected from three dairy farms and found 53.6% were positive for Theileria annulata. Age and breedwise incidence indicated as 58% above one year of age, 36% below one year of age, 56.7% in pure exotic breeds, 45% in crossbreds and 25% in indigenous cattle with CF titres of 1:5 to 1:40 for Theileria annulata.

Tuzer (1982) examined blood smears from 112 cattle and revealed Theileria annulata in 15 (13%), Babesia bigemina in 13 (12%), Babesia bovis in 39 (35%) Babesia bigemina along with Theileria annulata in one and Anaplasma marginale in one. In another 256 clinically healthy cattle 53 (21%) were infected with Theileria annulata, 36 (14%) with Theileria mutans one with Anaplasma marginale and two with Anaplasma centrale. He recorded most clinical infection in cattle during July and August months.

Anandan et al. (1983) diagnosed 6 of 28 calves, 13 of 196 adult cattle to have been affected with Theileria annulata during April to December 1982 in

Tamil Nadu. Boophilus microplus and Hyaloma hussaini ticks were found on the infecting calves.

Anandan and Lalitha (1984) in their analysis of records 126 cases of bovine tropical theileriosis presented for treatment at Madras Veterinary College between 1971 and 1982, observed the distribution of this disease in all districts of Tamil Nadu state, particularly in Madras region. Few cases were seen in the Salem and Nilagiris regions out of which 14% of affected animals were calves and high incidence was recorded with seasonal peaks in summer (March-April) and the monsoon (August-November). The tick vectors were identified as species of Hyalomma.

Tanwar et al. (1984) reported Theileria annulata infection in 18 of 42 sick indigenous Rathi calves aged 10 days to 3 months during the year 1979-80 by microscopic examination of smears of blood or fluid from enlarged lymphnodes. After treatment with diminazene aceturate and oxytetracycline combination. Fifteen of the infected calves recovered and the vector was evidently found to be Hyalomma anatolicum.

Venkataraman et al. (1984) screened 410 crossbred and native cattle sera by complement fixation test and found 138 (33.65%) were positive for T.annulata infection

where as only 24 (5.85%) were found to be positive as revealed by examination of blood smears. Cattle of less than 1 year age were found to be highly susceptible.

Garcia Fernandez et al. (1985) carried out examination of thin blood smears from 427 apparently healthy cattle from 7 municipal slaughter houses in Andalusia, Spain, between 1973 and 1978. The authors recorded Theileria annulata in 21 and Theileria mutans in 2 animals. Three animals with Theileria annulata infection also had Theileria mutans and 7 had Babesia bovis.

Yadav et al. (1985) carried out blood smear examination in Haryana state between 1975-1982 found 222 of 1081 crossbred cattle at 2 locations were infected with Theileria annulata. Haemoprotozoan infections were commonest in April-November (Summer-Post monsoon) coinciding with increase activity of the Hyalomma anatolicum population.

Raja et al. (1986) while studying incidence of bovine theileriosis in relation to vector potential in Tamil Nadu between 1974-78 reported that the highest incidence was in Madras city (150 cases) followed by Tirunelveli District (34), North Arcot (28), Tiruchirapalli (11), Coimbatore (9) and South Arcot (9),

Dharmapuri (7), Kanyakumari (5) and Chingleput (4), Most (88.59%) of the infected animals were exotic and crossbred cattle while the remainder were indigenous breeds. The ticks that transmitted the disease were identified as Hyalomma sps. Haemophysalis, bispinosa, Boophilus sps, Rhiphicephalus sp, Amblyomma integrum, Ornithodoros sqivignyi and Otobius magnini.

Rao et al. (1986) reported that theileriosis could be diagnosed in 287 cattle and 285 sheep between 1978 and 1983 most frequently during the period between May and September in Andhra Pradesh.

Sisodia and Mandial (1986) identified 18 crossbred cattle positive for theileria, 2 for anaplasma and 2 had a mixed infection of anaplasma and theileria in 111 crossbred cattle of various age groups in the Military Dairy Farm, Veterinary College Dairy Farm, Mhow and nearby villages in Madhya Pradesh.

Ahmed et al. (1987) randomly selected 501 dairy cows between July 1985 and June 1986, examined for blood protozoal parasites. Of the Friesian cattle 38 (7.6%) were infected with Theileria annulata and 16 (3.2%) died, which were imported to Kuwait from West Germany. Infected animals were found only during the period

from March-June. Hyalomma anatolicum anatolicum ticks were found to transmit the disease in cattle.

Bansal et al. (1987) detected Theileria annulata infection in 47 to 90% of 665 cattle by employing fluorescent antibody technique in randomly selected 4 farms in Uttar Pradesh and only 7 to 15% of cattle on three of the farms while the incidence was 75% on a 4th Farm by direct blood smear examination. The prevalence of parasitaemia was high (25 to 60%) in young stock from 3 farms. Animals of all age groups were carriers of the infection without any evidence of clinical symptoms. All 4 Farms had a strict regimen of vector control and although ticks were present, their numbers were low.

Caille (1987) carried out a serological survey on the prevalence and seasonal incidence of haemoprotozoan infection in livestock in Somalia by ELISA and recorded 71.2% of cattle 61.7% sheep were positive for antibodies against Theileria annulata mesozoite antigen.

Cakmak (1987) reported that out of 494 sera samples from 185 animals examined from 1984 to 1986 by IFAT 12 were positive for Theileria annulata in a herd in the village of Beytepe (Central Anatolia) in Turkey. The low infection rates were attributed to the altitude of 1100 m and to regular treatment with acaricides resulting in low tick infestation.

Dumanli and Ozer (1987) examined blood smears from 69 cattle suspected of protozoal diseases in Elazig region and reported clinical infection with Theileria annulata in 20 (29%), Theileria annulata plus Theileria mutans in 14 (20%). Latent infection with Theileria annulata, Theileria mutans and Theileria annulata plus Theileria mutans were found in 4, 8 and 3 respectively. On screening 261 healthy cattle latent infection with Theileria annulata, Theileria mutans and Theileria annulata plus Theileria mutans were found in 6 (2%), 96 (37%) and 51 (20%) respectively. In a third group of 4 suspected cattle 2 were positive for Theileria annulata. Clinical disease was commonest during the months of May, June and July.

Mallick et al. (1987) processed 805 peripheral blood smears prepared from febrile cases of 254 indigenous cattle and 88 crossbred cattle in India between 1978-1985. The authors found 4.72% of indigenous 20-45% crossbred cattle were infected with Theileria annulata. The majority of clinical cases of theileriosis were recorded during the period from June to October each year.

Shaw (1989) carried out examination of 1434 blood smears and 337 serum samples collected from intensive

cattle development centres and cattle farms of Kashmir valley and found incidence of babesiosis (1.8%), theileriosis (1.4%), mixed infections of anaplasmosis plus theileriosis and anaplasmosis plus babesiosis ranged from 0.69% to 1.53% respectively. Theilerial antibodies detected by the complement fixation test were present in 91 (33%) of the serum samples.

Mohanty et al. (1990) conducted survey from April 1975 to March 1990 and collected blood smears of 50,232 from 59,192 heads of cattle from different places of Orissa and observed 4.6% of cattle infected with theileriosis. Majority of the cattle which were positive for theileriosis belonged to the costal districts than hilly and forest rich districts.

Pradhan et al. (1991) carried out a serological survey and examined 1872 serum samples of cattle (Exotic 285, crossbred 1317 and indigenous 270) from 6 different districts in Orissa and recorded 58% seroprevalence of theileria infection as against demonstration of theileria particles only in 14.16% of blood smears.

Sinha and Verma (1991) processed blood smears from 1060 crossbred (HF) cows, heifers and young calves

suffering from continuous fever in and around Ranchi and found 272 (25.66%) animals were positive for theileriosis with highest incidence recorded in July (34.59%) and lowest in December (3.12%). Analysis of seasonwise incidence of the data indicated highest incidence during monsoon (29.20%) followed by summer (26.98%) and winter (9.79%).

Varshney (1991) carried out epidemiological study on blood protista in different categories of dairy animals in four villages of Kaira district of Gujarat state by examining 767 blood smears and observed the incidence of theileriosis as 45.9%.

2.2 SYMPTOMATOLOGY

Gautam et al. (1970) described symptoms of theileriosis in four Danish red bulls, three Jersey bulls and a Holstein yearlings as pyrexia, swelling of superficial lymphnodes and anaemia. Haemoglobinuria was however observed only in two cases.

Vulchovski and Pavlov (1970) reported nine cows to have died from theileriosis, three with the hyper acute, five with the acute and one with the subacute form of the disease. The authors observed small granular lesions in the mucosa of abomasum, bladder and

intestines and in the kidney. Glial proliferation and neuronophagia were seen in parts of the cerebellum as postmortem findings.

Waltschowski and Pawlow (1970) recorded abortions in six cows after 4-6 days of the appearance of clinical signs of theileriosis mostly in the 3rd to 7th months of pregnancy and Koch's blue bodies were demonstrated in capillary endothelium of the aborted foetus.

Sharma and Gautam (1973) observed cerebral form of theileriosis due to Theileria annulata infection in a 17 days old Haryana calf suffering from high fever, enlargement of superficial lymphnodes, severe anaemia, haemoglobinuria, jaundice, extreme weakness and emaciation. Nervous symptoms were shown at the terminal stages of the disease and Koch's blue bodies were demonstrated in impression smears from the brain, liver, spleen and lymphnodes.

Srivastava and Sharma (1976) induced experimental infection of Theileria annulata through infected ticks feeding and recorded cerebral involvement in two cases.

Gill et al. (1977) experimentally induced Theileria annulata infection in a series of experiments involving three years old crossbred calves. The main symptoms

were found to be fever, swelling of lymphnodes with postmortem findings of oedema and haemorrhages in lymphnodes, spleen and also in most serous and mucous membranes. Ulcers were consistently found in the abomasum but rarely in other parts of the digestive tract.

Sharma and Gautam (1977) diagnosed 686 cases of Theileria annulata infection in Hissar during 1969-75. Of these all the 114 cases of European breeds of cattle usually developed acute form of the disease and all the age groups of animals were affected. Some pregnant animals aborted. Clinical symptoms included petechial haemorrhages, haemorrhagic blotching of the conjunctiva, and haemorrhagic spots in the perineal region in indigenous calves but not in exotic and crossbred animals. Icterus, bilirubinuria, haemoglobinuria, cutaneous lesions and relapses were reported in some recovered animals.

Giles et al. (1978) observed an outbreak of theileriosis in Masai cattle and found neurological signs of turning and circling dysmetria, dysergia with terminal semicomatose state. Postmortem findings were characteristic of East Coast fever such as presence of large numbers of schizonts in many fields in the brain impression smears.

Bulman et al. (1979) recorded symptoms of tropical theileriosis in 4 cattle as pyrexia (42°C) anorexia, watery discharges from both eyes, slight constipation and congested conjunctival mucous membrane.

Karunanidhi et al. (1982) observed typical case of Theileria annulata infection in a Holstein Friesian crossbred cow and recorded symptoms of hyperpyrexia, inappetence, cessation of rumination, dribbling of saliva from mouth, bilateral serous nasal discharge, swelling of superficial lymphnodes and icteric mucous membrane. On the fourth day of clinical examination development of unusual skin eruptions, papules over the vulval lips and underneath the base of the tail, utricular swellings all over the body and in the eighth day opacity of the right eye and oedema were observed.

Khanna et al. (1982) experimentally induced Theileria annulata infection in 20 calves and observed nervous symptoms like circling movements or lying down with constant paddling movements of legs in 4 calves. During the last stage, calves were unable to stand up, became unconscious and eventually died with in 24 to 72 hours after development of the symptoms. The remaining 16 calves suffered from systemic form of theileriosis without any nervous symptoms.

Manickam et al. (1984) observed during the course of Theileria annulata infection in three calves development of wide spread skin nodules with intense infiltration of lymphocytes in such nodules.

Suresh et al. (1986) identified theileriosis associated with acetonaemia in a crossbred cow and observed reduced appetite, profuse salivation, lacrimation, hyperaesthesia, paleness of conjunctival and vaginal mucous membranes, fever (41°C) and swelling of superficial lymph nodes. There was increase in the pulse and respiratory rates (90 and 27 per minute) while the milk yield was reduced from 15 lts to ½ lt/day.

Anandan et al. (1988) experimentally induced theileria infection with various strains of theileria and found Madras strain to be milder than Hissar strain. The experimental disease with Madras strain was slow in onset and mild in nature with lower mortality rate, while the Hissar strain initiated the symptoms quickly and the disease was acute with higher mortality rate.

Dumanli and Ciftci (1988) recorded gross lesions of pallor of the conjunctival mucosa, jaundice, enlargement of lymph nodes, bronchopneumonia in four splenectomized calves experimentally infected with Theileria annulata.

Prasanna Kumar et al. (1988) reported clinical symptoms of theileriosis in crossbred cattle such as high fever (105^oF to 107^oF), anorexia, weakness, enlargement of superficial lymphnodes, increase in heart and respiratory rates, decrease in milk production, rough hair coat and pale mucous membrane.

Unsuren et al. (1988) studied 13 dairy cattle naturally infected with Theileria annulata in Turkey and observed marked anaemia, dyspnoea, and enlargement of lymph nodes, decreased milk production in all cases.

Jayathangaraj et al. (1991) recorded theileriosis in outpatient unit of Madras Veterinary College in a cow aged 3 yrs with a history of persistence of frequent regurgitation and dung with poorly digested material since 4 days, and the cow responded well to the Barenil and wolicycline when given along with kaolin.

Mallick (1991) reported 2 clinical cases of bovine tropical theileriosis in villages near Izatnagar (U.P) during the years 1989-90 with severe involvement of both eyes apart from the usual symptoms of fever, lymphadenopathy, coughing, nasal discharge, anaemia and weakness, with lacrimation, oedematous swelling of eyelids, conjunctivitis, keratitis, corneal opacity and bulging of eye balls.

Sudhan et al. (1992) reported a case of cutaneous theileriosis in six year old nondescript cow with high fever, (105°F) and utricularial lesions measuring about 0.5 to 1 cm in diameter spreading throughout the body in addition to signs of intense itching and scratching of the body, off fed, jaundice and enlargement of superficial lymphnodes.

2.3 HAEMATOLOGICAL CHANGES

2.3.1 Total erythrocyte count (TEC)

Oteng (1969) observed piroplasm and schizont of Theileria mutans to penetrate into the host cell and to cause destruction of the red blood cells leading to death of animal due to severe anaemia in Australia. The older animals appeared more susceptible to this disease.

Nangia et al. (1971) recorded total erythrocyte counts as 12.5 million/mm³ at 0-2 months of age and observed a decrease in values with advancing of age and reached 9.9 million/mm³ at 1-2 yrs and the absolute values of erythrocyte indices (MCV, MCH, MCHC) increased with age in Haryana male calves.

Aleucar (1972) reported average value of red blood cell count in Zebu cattle of the Gir breed as 6.6

millions/mm³ by taking the fresh samples from two bulls and 20 cows in good health which were imported more than three years previously to Saopaulo.

Jeon et al. (1973) experimentally inoculated theilerial infection into 8 cattle and observed the red blood cell count to decline by about 50 days and only increased again after 120 days of inoculation.

Sharma et al. (1973) reported decrease in erythrocyte counts with increasing age in all species while mean corpuscular volume, mean corpuscular haemoglobin and erythrocyte sedimentation rates tended to increase. The authors recorded mean erythrocyte count (million/mm³) in adult animals as 7.57 in cattle and 5.13 in buffaloes.

Mollerberg (1975) studied various biochemical values in 386 Swedish calves between March 1973 and February 1974. The average age of the calves was 28 ± 10 days and about 15% had 6.0 x 10⁶ erythrocytes or less/ml indicating about 13-35% of the purchased calves had iron deficiency anaemia.

Danov (1977) observed mean red cell counts to range from 4.2 to 7.1 million in 700 Danish black pied, 350 Danish red and 780 improved local Bulgarian red cows respectively. The lower counts were confined to local Bulgarian cows.

Laiblin (1978) conducted clinical studies on experimentally infected Theileria annulata infection in ten steers and recorded erythrocytopenia, thrombocytopenia before the appearance of erythrocytic forms in circulation. It was considered that the animals had an aplastic anaemia due to toxin-mediated lesion in the bone marrow.

Baumgartner (1979) noticed erythrocyte counts of 3.9-6.7 million/mm³ in 3 groups of female cattle from the age of 4-6 weeks upto their second calving. Blood samples were taken on average every 6 weeks. A fourth group of animals served for comparison.

Dhar and Gautam (1979) experimentally induced Theileria annulata infection in 10 disease free male calves aged 1-16 weeks with infected ticks. There was parasitaemia ranging from 0.1 to 15% and evidence of increased erythrophagocytosis which was evident from the examination of the spleen impression smears with gradual decrease in RBC counts until the chronic phase of the disease indicating clinical anaemia with maximum fall in RBC count occurring after peak parasitaemia. This lead to the conclusion that a factor other than parasitic destruction of erythrocytes was responsible for anaemia. This was thought to be an autoimmune mechanism causing increased erythrophagocytosis.

Total erythrocyte count in fifteen calves infected with Theileria annulata showed decrease in R.B.C. count before treating with diethylcarbamazine citrate (Sharma et al. 1980).

Lal and Soni (1985) reported anaemia in acute Theileria annulata infection in crossbred calves with maximum destruction of erythrocytes (58%) observed between 14 and 15 days after infection and a marked decline in total R.B.C. counts with increase in parasitaemia.

Haider and Siddiqui (1989) observed significant difference between summer and winter erythrocyte counts ($10^6/\text{ml}$) as 6.7 and 7.6 respectively in 100 healthy cows from various dairy farms in Karachi.

Randhawa et al. (1990) recorded significant decline in PCV, Hb, TEC values with no significant alteration in differential protozoal count in seven clinical cases having mixed infection of Theileria annulata and Anaplasma marginale in crossbred cow calves, less than 2 months of age.

2.3.2 Packed cell volume (PCV)

Nangia et al. (1971) observed packed cell volume values to be highest in 0-2 months Haryana male calves. There was gradual decrease in the PCV with advancing age.

Ryam (1971) reported higher values of packed cell volume in Charolais cattle and wide individual variations in five Jersey cows when blood samples were analysed for cows (over 2½ years old) of Charolais, Hereford Aberdeen Angus, Jersey, Friesian and short horn breeds .

Tennant et al. (1975) identified direct correlation between packed cell volume and serum iron concentration.

Dhar and Gautam (1979) experimentally induced Theileria annulata infection in male calves aged 1-6 weeks and observed gradual fall in packed cell volume until the chronic phase of the disease indicating clinical anaemia. These authors found that an auto-immune mechanism causing increased erythrophagocytosis leads to fall in packed cell volume but not necessarily with the number of parasitized erythrocytes.

Khanna et al. (1980) while conducting drug trials in three groups of six infected crossbred calves with Theileria annulata found equal fall of packed cell volume in all the three groups.

Packed cell volume was not significantly different between genetic groups or between different age groups and ranged from 31.3 ± 1.39 to 37.3 ± 2.39 in 4 Haryana

calves and 4 of Haryana F₁ crosses with Jersey, Brown-swiss and Holstein Friesian kept in a thermoneutral environment at 16-19, 21-24, 26-29, 31-34 and 37-40 months of age, which are comparable with values for Zebu cattle (Khubsingh and Battacharya, 1985).

Lal and Soni (1985) observed 53% loss of packed cell volume in calves after 14-15 days of Theileria annulata infection due to erythrophagocytosis by macrophages in lymphnodes, spleen, liver and bone marrow and by monocytes in circulating blood there by causing anaemia.

Experimental infection with Theileria in splenectomized buffalo calves indicated marked decline in packed cell volume, haemoglobin etc. directly proportional to increase in percentage of parasitaemia. Such changes were insignificant in crossbred calves (Jersey x Red Kandhar). Splenectomized calves exhibited debility and loss of weight (Shastri et al. 1985).

Dhar et al. (1990) carried out a drug trial with Buparvaquone found the packed cell volume to decrease initially with Theileria annulata infection and it returned rapidly to pretreatment values after treatment by the time the general health of the calves improved.

Sharma and Mishra (1990) carried out drug trial in 4-7 days old six male calves experimentally infected with Izatnagar isolate of Theileria annulata and divided the animals into treated and untreated controls. By treating the infected calves with Buparvaquone they observed 17.4% fall in packed cell volume in the treated as compared to 40.3% fall in the control groups.

2.3.3 Haemoglobin (Hb)

Nangia et al. (1971) observed the haemoglobin values to decrease with advancement of age along with total erythrocyte count.

Rayam (1971) reported haemoglobin values to be higher in charolais and lower in Jersey cows when estimated the samples in cows (over 2½ years old) of charolais, Hereford, Aberdeen Angus, Jersey, Friesian and short horn breeds.

Aleucar et al. (1972) recorded mean haemoglobin values of 13.8 g% in 2 healthy bulls and 20 cows, which were imported more than three years into Saopaulo.

Sharma et al. (1973) found relatively high haemoglobin, mean corpuscular volume and mean corpuscular haemoglobin values in buffaloes than in cattle.

Mollerberg (1975) noticed 35% of 386 calves had 10 g/100 ml or less haemoglobin values when examined between March 1973 and February 1974 indicating that 13-35% of the purchased calves had iron deficiency.

Baumgertner (1979) studied on 3 groups of female cattle from the age of 4-6 weeks upto their second calving which had shown average haemoglobin values of 10.5-13.5 g/100 ml along with haematocrit value of 32-40%.

Dhar and Gautam (1979) recorded a gradual fall in haemoglobin concentration until the chronic phase of the disease in experimentally infected Theileria annulata in ten male calves aged 1-16 weeks with parasitaemia ranging from 0.1 to 15%. The authors opined that this was due to autoimmune mechanism causing erythrophagocytosis.

Bolme + Schmokel et al. (1982) recorded subnormal serum iron values with normal haemoglobin in 29 healthy weaned Jersey calves aged 12-18 weeks reared on a standard diet. The mean values were agreeable generally with those reported in the literature.

Haemoglobin levels were significantly higher in Holstein Friesian x Hariana F_1 crosses with 10.75 ± 0.29 ,

10.58 \pm 0.37, 10.83 \pm 0.12 g/100 ml at 16-19, 21-24 and 31-34 months of age respectively when blood samples were collected from 16 bull calves and 4 Hariana calves and 4 each of Hariana F₁ crosses with Jersey, Brown swiss and Holstein Friesian samples were collected in thermoneutral environment (Khubsingh and Bhattacharya, 1985).

Sastri et al. (1985) reported marked decline in PCV in experimentally infected *Theileria* (by I/V inoculation of strain from buffaloes in Maharashtra, India) into splenectomized buffalo calves but it was not observed in crossbred calves (Jersey x Red Kandhari).

Shukla and Sharma (1991) inoculated the cell cultures at passage levels of P-10, P-50 and P-100 in varying cell concentrations into fifty crossbred male bovine calves (2-3 months) and observed decrease in haemoglobin, PCV and TEC during post inoculation and post challenge periods at each passage level with marked anaemia recorded at P-10 and P-50 levels but not at P-100 level.

2.3.4 Total leucocyte count (TLC)

Oteng (1969) observed *Theileria mutans* piroplasmae and schizonts penetrate into the host cell and cause destruction of lymphoid cells and neutrophils with lymphoid hyperplasia.

Nangia et al. (1971) recorded decreasing trend in lymphocyte percentage with age while neutrophils and eosinophils followed reverse order in Haryana male calves from birth to 2 yrs of age.

Ryam (1971) reported total leucocytes to be higher in Hereford and Charolais but lower in monocyte values while Friesian, charolais and Hereford cows had higher neutrophilic counts than Jersey, Aberdeen, Angus and short horn when blood samples are collected from cows (over 2½ years old) of Charolais, Hereford, Aberdeen Angus, Jersey, Friesian and Shorthorn breeds.

Aleucar et al. (1972) tabulated the average values of T.L.C. as 12,918/mm³ in two bulls and 20 cows with 33.8% neutrophils, 11.8% eosinophils, 0.2% basophils, 55.1% lymphocytes and 5.7% monocytes among imported Gir cattle at Saopauls.

Sharma et al. (1973) found average total leucocyte count (Thousands/mm³) as 11.34 in buffaloes and 8.34 in cattle. The percent of neutrophils in cattle was observed to be 22.6. The total leucocyte count gradually decreased with increase of age.

Danov (1977) collected blood samples yearly once for 7 years and observed the mean leucocyte counts to

range between 5850 to 7800 in Danish Black Pied, 350 in Danish Red and 780 in improved local Bulgarian Red cows.

Sharma and Gautam (1977) recorded total leucocyte counts to range from 3 to 5 thousand/ml in 686 cases of experimentally induced acute form of theileriosis involving 114 European cattle.

The leucocyte counts varied from 6250 to 9550/mm³ with 53-67% lymphocytes, 0-8% band granulocytes, 23-37% segmented granulocytes, 1-7% eosinophil granulocytes, 0-1% basophil granulocytes, 0.1% monocytes in 3 groups of female cattle from the age of 4-6 weeks upto their second calving based on examination of blood samples collected on an average of every 6 weeks (Baumgertnar, 1979).

Sharma (1979) identified significant differences in total leucocyte values which were lowest in Theileria annulata infected calves and intermediate in mixed infection with Anaplasma marginale.

Dumali (1987) reported that the leucocyte counts decreased with little change in the % of monocytes, eosinophils or basophils, neutrophils but increase in percentage of lymphocytes in three 6 months old splenectomized calves infected with Theileria annulata.

Banerjee et al. (1988) observed moderate leucocytosis ($18,628 \pm 3.93$ thousand/cmm) during early part of theileriosis infection which became almost normal (9779 ± 1.47 thousand/cmm) within 30 days, when treated with Butalex (WB 720 C) parentally in crossbred cattle.

Haider and Siddique (1989) observed significant differences between summer and winter leucocyte counts as 8,900 and 7,200/ml with eosinophils 4.2 and 3%, basophils 0.3 and 0.72; monocytes 4.2 and 4.38% respectively but there was no significant difference in neutrophils 36.3% and 36.7% and lymphocytes 55.5% and 55.2% when studied on 100 blood samples from healthy cows on various dairy farms in Karachi.

2.4 BIOCHEMICAL CHANGES

2.4.1 Serum iron

Cartwright et al. (1949) observed serum iron to range from 57 to 162 ug% in cows, 114 to 120 ug% in calves based on a colorimetric method of assay.

Brown (1966) studied the various biochemical values of blood in bovines and observed the relationship of serum iron in the range of 70 to 180 ug%, TIBC in range of 400 to 450 ug% and UIBC in a range of 280 to 350 ug%.

Frank et al. (1970) processed the serum samples of bovines and established the average serum iron values to vary from 158.29 ug% \pm 14.08 ug% and in diseased condition as 80.30 ug% \pm 27.25 ug% by colorimetric assay utilising a spectronic-20 (B & C, USA).

Mean serum iron values were higher at birth 170 ug/100 ml which fell to 67 ug/100 ml by 50 days of age in calves. The authors have also quoted the average values of the iron content of hay, maize, oats and milk (Mollerberg and Jacobson, 1970).

Gurtler and Schutzler (1971) noticed when blood samples were obtained from 31 German black pied calves shortly after birth and 2, 24, 48, 96 and 240 hrs after the first intake of colostrum serum iron fell from an average of 150 ug% after birth to 69 ug% at 96 hours.

Serum iron concentration, total iron binding capacity and the percentage saturation were measured in 87 healthy female Zebu cattle, varying in age from a few days to 17 years and it was observed that there was slight variation in mean values of serum iron concentrations during the first 7 years of life with maximum level recorded during the early adulthood (Tartour, 1973).

Blum and Zuber (1975) observed serum iron to remain relatively constant between one to eight years of age than iron in spleen, liver and bone marrow in female dairy cattle. They reported the iron concentrations to be always highest in the spleen and low in liver and bone marrow.

While examining 10 Zebu cows for 10 days, serum iron concentrations were found to be 50-200 ug (mean 131 ug/100 ml). Daily variations were observed in these values and the extent of fluctuations varied with individual cows (Sarror, 1975).

Tennant et al. (1975) reported that neonatal calves with haematocrits of 25% or less had significantly lower serum iron values (54.1 ug/100 ml) than the values recorded in calves with haematocrits above 25% which had 129.2 ug/100 ml and concluded that prenatal development of iron deficiency as an important cause of anaemia in neonatal dairy calves.

Wintrobe (1976) recorded the biochemical and haematological values in anaemic cattle and reported as 100 ug% serum iron in anaemic cattle.

Kaneko (1980) described normal serum iron values. as 97 ± 29 mg/dl in cattle. The serum iron values declined in severe iron deficiency anaemia, acute phase of inflammatory reactions, hypothyroidism and chronic

inflammation. It was reported to get elevated in haemolytic anaemia, iron overload and liver diseases.

Prahlad Singh et al. (1980) reported iron contents in the buffalo blood in district of Rhotak, Sonapat and Mohindergarh were 288.77 ± 32.64 , 247.57 ± 27.16 and 219.65 ± 11.57 respectively when 67 blood samples were collected from 24 villages in the three districts of Haryana between November 1976 and January 1977.

Serum iron concentration was lower in calves from birth to 4 weeks of age than in older cattle. Total iron binding capacity decreased while percentage saturation increased with advancing age observed by Sarror (1980) in 141 Zebu cattle.

Singh et al. (1980) observed significant decrease in serum iron with 114.68 ± 1.067 , 118.860 ± 1.452 , 117.709 ± 1.727 , 114.343 ± 1.612 , and 117.5 ± 1.443 on 0, 15, 30, 45 and 60 days after haematuria. Where as it was 76.916 ± 5.618 , 75.694 ± 4.727 , 75.552 ± 5.052 , 74.720 ± 0.975 and 72.133 ± 1.29 ug/100 ml serum in healthy control.

Pandey et al. (1982) observed the biochemical changes of experimentally induced nutritional anaemia, in cow calves and recorded normal values of serum iron as 158.21 ug%, UIBC 326.16 ug% and TIBC 483.45 ug%.

Serum iron levels were studied from birth to sexual maturity in 23 Surthi buffalo calves weaned at birth, fed colostrum 15-30 minutes after birth and reared by appropriate management and observed that the serum iron was higher in female calves during puberal and maturity periods than in male calves (Devaraj et al. 1985).

Szeplaki et al. (1985) determined serum iron values in intensively reared Holstein Friesian (a) and Romanion simmental nonintensively reared cattle (b). The authors observed 36.4% in a and 37.9% and in b farm calves suffered with normocytic normochromic anaemia, on farm a 13.6-97% of calves had serum iron values less than 100 ug/dl. About 5 to 55% had total iron fixation capacity greater than 500 ug/dl in b farm.

Bomba et al. (1986) measured serum iron content in 21 calves chosen from 1800 calves kept in a large capacity calf house and observed highest serum iron content after weaning. Individually half of the calves had subnormal iron values at 2 weeks of age, 10% at 5 weeks. When they were fed twice daily with milk replacer, hay, grain mix and unlimited water.

At the age of 9 weeks the calves were allowed to wean and were fed with hay silage and grain. Out of these calves 20% also had subnormal serum iron values.

Welchman et al. (1988) measured iron in calves reared for veal at the start of rearing period and at 16-20 weeks of age, which were fed with milk replacer either alone or with straw or dry feed of varied iron content. The authors observed that the haemoglobin concentration reached a mean value of 12.4 ± 1.1 g/dl similar to control calves. There was no further increase in haemoglobin when iron was fed indicating that there was sufficient iron in the diet for normal erythropoiesis.

Ghosh and Sinha (1991) while analysing various etiological factors causing anaemia observed that helminthic infestation was responsible for 48.57%, deficiency due to copper cobalt and phosphorous for 31.43%, haemoprotozoan such as theileria, anaplasma and trypanosoma for 12.17% and ectoparasites such as ticks and mites for 7.14% of cases. Various blood parameters like haemoglobin, PCV and TEC as were reported to be 6.257 ± 0.215 g/dl, $22.621 \pm 0.82\%$ and 3.35 ± 0.095 million/cmm respectively. Levels of plasma protein, albumin and phosphorus were not

significantly ($P < 0.01$) different in anaemic animals but levels of Fe, Cu, Co were significantly lower ($P < 0.05$) in them.

2.4.2 Blood glucose

Bansal et al. (1977) recorded blood glucose values in experimentally inoculated T.annulata in five male calves. The authors observed Hypoglycaemia in all the calves throughout the trial.

Sethuraman and Rathor (1979) reported a mean normal values of blood glucose as 46.2 ± 2.1 mg% in healthy cattle and mean values of 41.56 ± 0.15 mg% in buffaloes.

Anantwar et al. (1986) reported hypoglycaemia in five crossbred cows which manifested clinical signs of theileriosis associated with Ketosis and observed the blood glucose values to range from 22 to 35 mg%. The authors concluded that the hypoglycaemia in these cases was responsible for the development of secondary ketosis. Treatment with oxytetracycline along with chloroquine was effective and blood glucose levels improved when 25% of 500 ml glucose solution was given to all the cases daily for four to five days.

Udaysankar et al. (1986) recorded a mean temperature, pulse, respiration rates as 100.77 ± 0.12 , 59.33 ± 0.21 and 17.5 ± 0.56 respectively in healthy cattle with a mean values of blood glucose as 42.85 ± 1.17 mg%.

Yadav and Sharma (1986) estimated blood glucose during the course of T.annulata infection in calves and observed fall in glucose, calcium, protein, phosphorus, magnesium and potassium values.

Blood and Radostitis (1989) in their classical text book of medicine described that the blood glucose levels of healthy cattle as 35-55 mg%. There was no mention of values of blood glucose in theileria affected cattle.

Subba Raja et al. (1989) recorded a mean values of blood glucose in seven crossbred cattle of Rushivalley Farm as 41.39 ± 1.03 mg%, 39.05 ± 0.55 mg%, 43.47 ± 1.12 mg% in early, mid, late lactations respectively.

Venkateswarlu et al. (1990) indicated the mean blood glucose values as 50.45 ± 1.05 in 7 healthy cattle along with the mean values of PCV and haemoglobin 30.57 ± 2.26 and 12.30 ± 0.7 respectively.

2.5 CLINICAL TRIAL

2.5.1 Buparvaquone

McHardy et al. (1985) tested series of hydroxynapthoquinones (derivatives of parvaquone) and found Buparvaquone to have cured all 13 cattle infected with T.parva (@ 2.5 to 5 mg/kg) and all 6 infected with T.annulata (@ 2.5 mg/kg). Parvaquone cured 9 of 10 cattle (@ 20 mg/kg).

Dhar et al. (1986) reported injection of Buparvaquone (@ 2.5 mg/kg) intramuscularly on the 11th day of infection to the experimentally infected (Hissar isolate of T.annulata) crossbred calves along with Livogen and Macrabin (@ 5 ml and 2 ml i/m respectively) for 12 days. This regimen showed a promising result in treating the bovine tropical theileriosis.

Morgan et al. (1986) observed that a single intramuscular injection of Buparvaquone was much more effective than parvaquone when given to the experimentally infected cattle with T.parva or T.annulata at the time when first signs of illness appeared.

Dhar et al. (1987a) could not detect the theilerial schizonts and prioplasms in the blood smears and

lymphnode biopsy, after 6-15 days of treatment with a single intramuscular injection of Buparvaquone (BW 720 C) @ 2.5 mg/kg body weight in 19 crossbred cattle infected with bovine tropical theileriosis.

Dhar et al. (1987b) reported no fall in haemoglobin or packed cell volume in 5 crossbred calves when simultaneously inoculated a single intramuscular injection of Buparvaquone @ 2.5 mg/kg and ground up tick supernate. They concluded that Buparvaquone may be used for chemoprophylaxis against bovine tropical theileriosis in neonatal bovine calves.

Banerjee et al. (1988) conducted an experiment on 15 crossbred cattle, suffering from clinical theileriosis in an organised farm in Calcutta and divided 15 animals into two groups. Group A comprised of 10 animals which were given a single I/m injection of Buparvaquone @ 2.5 mg/kg while all the 5 animals of group B received a second injection of Buparvaquone on the 6th day of first injection. Out of the 10 animals of group A, temperature of seven animals came down to normal within 48 hrs, in other 3 animals it took 96 hours. Temperature of group B animals came down within 48-72 hours of second injection. Temperature of all the treated animals became normal within 8-10 days.

Dhar et al. (1988) divided 14 crossbred calves infected with Hissar isolate of T.annulata and divided them into two equal groups A and B. Animals of group A were treated with Buparvaquone on day 11 PI when clinical signs of theileriosis were apparent. Animals of Group B were given haematinics daily for 12 days by intramuscular injection in addition to Buparvaquone. In group A 2 calves died of cerebral theileriosis and 5 were clinically cured. However 4 of these 5 calves later died of anaemia. In group B all the calves were clinically cured and none died during one month observation period. The parasitaemia declined to 1% with in 14 days of treatment. Haemoglobin concentration and PCV were elevated and preinfection values were soon restored.

Unsuren and Kurtdede (1988) treated 28 cattle with a mean 34.6% (12-85%) parasitaemia infected with Theileria annulata and injected two doses of Buparvaquone along with 1000 ml dextrose 5% intravenously and 3000 I.U vitamin E, 900 mg dicalcium phosphate, 15 mg sodium selenite, 60 mg copper sulfate and 75 mg cobalt sulfate by orally daily to three cattle, whose general condition was poor and still had intact piroplasms. Of the 28 cattle, 3 died, were sent for slaughter and 24 were discharged in fairly good condition.

Bansal and Sharma (1989) while evaluating the antitheilerial activity of Buparvaquone, given single intramuscular injection to the calves which were already infected experimentally with T.annulata on day 0 (group 1) day 8 (group 2) and day 12 (group 3) post infection. The animals in groups 4 and 5 were untreated and challenge controls respectively. All the recovered animals from groups 1-4 were challenged with a lethal dose of T.annulata at 6 weeks post infection and observed that all animals were resistant to the homologous challenge while controls showed typical antemortem and postmortem lesions of theileriosis.

Michael et al. (1989) emphasized use of Buparvaquone @ 2.5 mg/kg 1/m in chronically infected cattle with T.annulata which may have dual beneficial effect of reducing the pathogenic effects of theileriosis there by permitting restoration of an impaired immune system, thus increasing resistance to other infections observed while conducting drug trials on chronic undulating T.annulata infection in a herd of 44 Friesian cows in Egypt.

Shastri (1989) treated 17 clinically ill calves with T.annulata by giving Buparvaquone @ 1 ml/20 kg body weight as deep intramuscular injection. Seven of

the calves did not respond and died while others survived (58.8% efficacy) none of the ten calves aged 8-25 days given Buparvaquone as a preventive measure developed the disease, while four of the six not treated developed theileriosis and died.

Dhar et al. (1990) found that in theileriosis the haemoglobin concentration and packed cell volume decreased initially after infection but rapidly returned to pretreatment level after treatment with single dose of Buparvaquone @ 2.5 mg/kg body weight.

Sharma et al. (1990) divided 2 groups of 3 animals each, which were infected with Izatnagar isolate of T.annulata with 20% or above parasitaemia. Animals of the 1st group were treated with intramuscular injection of Buparvaquone @ 2.5 mg/kg and observed decline of parasitaemia to less than 1% within 4 days. Temperature fell from 41°C to 39°C. Haemoglobin and PCV had fallen to 21.5% and 17.4% in treated animals as compared to 45.6% and 40.3% in control group. All animals in the control group died of acute theileriosis on day 27 PI. There was no mortality in treated groups.

Hashemi-Fesharki (1991) compared chemotherapeutic value of Parvaquone and Buparvaquone against T.annulata

infection in 159 pure and crossbred cattle. Parvaquone treated animals recovered at the rate of 60.7% and with Buparvaquone was 88.7% with no significant side effects. However, there were no relapses of the disease with use of either compound.

Sudhan et al. (1992) treated a typical case of cutaneous theileriosis in an advanced stage in indigenous cow. Butalex (Buparvaquone) in two doses and Avil for 3 days. Eventhough the organisms disappeared from circulation the animal succumbed to the disease.

2.5.2 Oxytetracycline long acting and chloroquine phosphate

Hegde et al. (1971) reported that intramuscular administration of Nivaquine (chloroquine sulphate) @ 20 ml on first day and gradually reducing to 10 ml on 3rd day in cattle with theileriosis resulted in complete cure within 6-10 days. Supportive treatment with broad spectrum antibiotics and preparations containing calcium gluconate and vitamin B complex expedited recovery.

Mathur et al. (1971) studied efficacy of Nivaquine along with Achromycin and supportive symptomatic therapy which failed to cure acute clinical case of theileriosis

in Jersey bulls. While combined therapy of Berenil, Nivaquine and Terramycin administered in initial stages to 4 subclinical cases could result in disappearance of protozoa from circulation.

Chhabra et al. (1972) reported for the first time a case of theilerial infection in a buffalo besides two Holstein Friesian heifers and treated effectively with Nivaquine and chloramphenicol with glucose saline, tonics and haematinics.

Rao et al. (1973) conducted drug trial on eight ailing Jersey cattle divided into two groups of 4 animals each. Animals of group I received 40 ml of vesadin intravenously and 40 ml subcutaneously for 3 days followed by Achromycin 500 mg intramuscularly for 5 days coupled with glucose saline. The group II received Nivaquine 20 ml and Achromycin 500 mg intramuscularly for five days. Both the groups received liver extract on alternate days. In group II blood smears became negative for theileria in 2 animals by 3rd day. While in other 2 animals no theilerial parasite could be detected after 7th day. In group I blood smears became negative only after 3 weeks.

Avessalomov and Baenov (1977) found 97% of the cattle recovered from theileriosis, when given antimalarial

preparation of chloroquine phosphate @ 1.25 g/100 kg once daily for 5-6 days along with symptomatic supportive treatment.

Laiblin and Muller (1977) reported that a therapeutic dose of 15 mg/kg chloroquine diphosphate was injected intramuscularly daily for 4 consecutive days in the initial stage of rise of temperature could cure theileriosis in calves but failed to prevent the acute clinical symptoms which sometimes resulted in deaths.

Gill et al. (1978) observed that treatment with long acting oxytetracycline (1 or 2 doses at 20 mg/kg I/m) or oral tetracycline (16 mg/kg body weight) for 8 days when given to 3 months old calves infected with T.annulata on the commenced day of infection the calves failed to react to the infection.

Khanna et al. (1980) identified that long acting oxytetracycline and rolitetracycline showed better response than monectone based on the results of the three groups of experiment comprising of six infected cross-bred calves in each.

Rakhimov et al. (1980) recommended a combination of Delagil (chloroquine diphosphate) @ 15 mg/kg body .

weight with sulfalene (INN: sulfametopyrazine) @ 20 mg/kg along with erythromycin @ 5 mg/kg for treating the T.annulata infection in cattle.

Tripathy (1981) found administration of 10 mg of oxytetracycline hydrochloride intravenously (after diluting with equal volume of distilled water) per kg body weight along with Berenil @ 15 mg/kg intramuscularly which proved superior to other treatments such as oxytetracycline @ 10 mg/kg intravenously. Oxytetracycline @ 5 mg/kg I/m tetracycline along with Berenil saved the life of animals though the recovery was slow.

Dwivedi et al. (1984) observed that diminazene @ 0.8 gr/100 kg body weight (2 injections at 24 hr interval) along with oxytetracycline @ 15 mg/kg I/m (3 injections at 24 hr interval) produced better results than diminazene or oxytetracycline alone. Where as chloramphenicol (15 mg/kg) treated did not completely eliminate the erythrocytic stage of infection.

Bansal and Sharma (1986) noticed single intramuscular dose of parvaquone (@ 10 mg/kg body weight) on the 1st and 2nd days of fever protected 4 of 5 calves, where as with long acting oxytetracycline (20 mg/kg) underwent mild clinical reactions and recovered. But 3 of 4 control calves died.

El Magd et al. (1987) successfully treated T.annulata infection in naturally infected cattle by giving Terramycin (Oxytetracycline) @ 50 ml daily I/V for 3 days or 30 ml daily I/V for 5 days and found the drug was completely effective against T.annulata schizonts.

Prasannakumar et al. (1988) observed a single injection of levamisole @ 7-10 ml/cow and 5 ml/heifer intramuscularly along with five consecutive days of treatment with oxytetracycline @ 5 mg/kg with supportive therapy (viz. Imferon, Macrabin and ferrous sulphate), cured all four crossbred cows and a crossbred heifer suffering from theileriosis. The body condition and milk production were also significantly improved after treatment.

Bagherwal (1989) studied the efficacy of long acting tetracycline (Telon LA, M/S Merind, India) against 16 cases of T.annulata infection in exotic and crossbred cattle. Telon LA was given @ 20 mg/kg with 2-3 intramuscular injections at 48 hrs interval and could bring about cure while 2 crossbreds treated with 5-10 mg/kg by the same number of injections and interval succumbed to infection with typical signs of theileriosis.

Dhar et al. (1990) studied the efficacy of a single intramuscular injection of long acting oxytetracycline @ 20 mg/kg along with inoculations of GUTS in a group of crossbred calves and observed negligible clinicopathological reactions, Group B calves as control group without any treatment shown mild to severe reaction resulting in death of 3 of 6 calves. In group C all the infected, untreated control calves died of acute theileriosis. All the surviving calves of groups A and B withstood a lethal homologous challenge given on day 30 after immunisation indicating no difference in the immune status of the surviving calves of the two groups. D 2216

CHAPTER III

3. MATERIALS AND METHODS

3.1 MATERIALS

The present study consisted of two parts, the first part being preliminary study on the incidence of theileriosis in various parts of Andhra Pradesh based on available records and the second part was on the comparative efficacy of certain antitheilerial drugs like Buparvaquone and long acting tetracycline, (Oxyvet LA, M/S Sarabhai, India) in combination with chloroquine (Lariago, M/S IPCA India).

3.1.1 Hospital records

To study the incidence of theileriosis among cattle presented for treatment at Hospital, records of treatment at the Veterinary Polyclinic, Chittoor; College and City Veterinary Hospitals, Tirupati and Ambulatory Clinic, Thondawada were thoroughly screened to find out the incidence for the years 1986-91.

3.1.2 Farm records

In order to find out the incidence of theileriosis in the farm all the records of Indo-Swiss Project, Visakhapatnam and Cattle Farm, Lam, Guntur were screened for the years 1986-91.

3.1.3 Clinical cases

Thirteen clinical cases of theileriosis were selected and divided randomly into two groups, the 1st group consisting of 7 animals which were treated with Buparvaquone and the second group consists of 6 cows were treated with long acting tetracycline (Oxyvet LA) in combination with chloroquine (Lariago).

3.1.4 Collection of materials

Blood samples were collected from Jugular vein under aseptic condition using a 16 gauge hypodermic needles. About 3 ml of blood was collected into a dry glass vial containing disodium EDTA at the rate of 1 mg/ml of blood. The blood was mixed gently after replacing the cap and was used for the estimation of haematological parameters. And another 2 ml of blood was collected in a vial contain sodium fluride as a anticoagulant (10 mg/ml of blood). The sample was mixed gently after replacing the cap and used for estimation of blood glucose.

For separation of serum about 10-15 ml of blood was collected aseptically from all the animals individually in separate sterile test tubes.

Immediately after collection the samples were kept in a slanting position and were allowed to clot at 37°C for half an hour. After this the samples were kept in refrigerator to facilitate the retraction of clot and the serum samples were separated by decanting and centrifuging at 2000 rpm for 20 min to remove the residual blood cells. Duplicate sera samples were prepared from all the positive animals and one portion was processed on the day of collection and the other was stored in sterile screw capped vials and were kept in freezing chamber till use.

3.1.5 Therapeutic agents

The following drugs were tried in treating the theileriosis in cattle:

1. Buparvaquone (M/S Beecham Laboratories, UK)
40 ml vial containing 50 mg of 2-hydroxy-3
(Trans-4-butyrctohexy) methyl 1-4-napthoquinone
per 1 ml.
2. Lariago (IPCA Laboratories Ltd., Bombay) 30 ml
vial containing 64.5 mg of chloroquine phosphate
equivalent to 40 mg of chloroquine base per 1 ml.
3. Oxyvet LA (Sarabhai Chemicals, Baroda) 30 ml vial
containing 200 mg of Oxytetracycline per ml.

3.2 METHODS

3.2.1 Incidence of Theileriosis

3.2.1.1 Incidence in Hospitals

Incidence in Hospitals were analysed among the total number of bovine cases presented for treatment and cases suffering from theileriosis was determined. The data were analysed with relation to year, institution, month, breed from cases recorded for last few years and actual cases handled were considered together.

3.2.1.2 Incidence in Farms

Incidence in farms have been calculated in relation to the total number of bovine population present in that farm during the respective periods of study.

3.2.2 Clinical examination

All the cattle admitted into the Hospital were thoroughly subjected to preliminary general and detailed clinical examination like recording the temperature, pulse, respiration, conjunctival mucous membrane, rumen motility and palpation of lymphnodes.

Once the animal is identified as suffering with pyrexia such animals blood smears prepared from the earveins were routinely stained by Giemsa's method and examined by light microscopy for the presence of intracellular thellerial organism. The clinical material were collected for the laboratory examination as detailed under collection of materials.

3.2.3 Haematological methods

3.2.3.1 Total erythrocyte count (TEC)

Erythrocytes were counted by using modified double Neubauers chamber (Schalm et al. 1975) and expressed in millions per cubic millimeter.

3.2.3.2 Packed cell volume (PCV)

The packed cell volume was estimated by microhaematocrit method as described by Schalm et al. (1975) using microhaematocrit centrifuge (Remicentrifuge) and expressed as percentage.

3.2.3.3 Haemoglobin (Hb)

The haemoglobin content of the blood was estimated using acid hematin method (Schalm et al. 1975) and expressed as grams percent.

3.2.3.4 Total leucocyte count (TLC)

Leucocytes were counted using modified double Neubauers chamber (Schalm et al. 1975) and expressed in thousands per cubic millimeter.

3.2.4 Biochemical methods

3.2.4.1 Estimation of serum iron

The estimation of serum iron was carried by the method of walker as described by Kolmer et al. (1959).

3.2.4.1.1 Preparation of glassware

All the glassware including reagent bottles, pipettes, volumetric flasks and syringes were thoroughly washed several times with tap water and then with double distilled water to make them iron free so as to avoid possible iron contamination.

3.2.4.1.2 Preparation of reagents

Standard iron solution was prepared by dissolving 0.700 g of crystalised ferrous ammonium sulfate (BDH, Analar) in 50 ml of distilled water to this 20 ml of 10% sulfuric acid (Merk, GR) was added. This was warmed slightly and to this N/10 potassium permanganate solution (Sarabhai chemicals GR) was added a drop at a time with

stirring until a faint permanent pink color was obtained which remained at least for 30 seconds after stirring. The solution was cooled to room temperature and transferred quantitatively to one litre volumetric flask diluted to the mark with double distilled water and mixed well. The standards were stored in a tightly stopped bottles. Each ml of this solution contained 0.1 ug of iron.

Potassium persulfate solution was prepared by taking 7 gm of potassium persulfate (Quantogens, AR) into 100 ml volumetric flask to which double distilled water was added slowly upto the mark. The flask was shaken and allowed to stand for few hours. In this way a saturated solution of potassium persulfate was prepared in which the salt settled to the bottom will get dissolved to replace the lost persulfate, if any as a result of slow decomposition. The supernatant solution was therefore used.

Potassium thiocyanate solution was prepared by taking 146 g of potassium thiocyanate (Loba chemicals, GR) in a 500 ml volumetric flask. The salt was dissolved and was diluted to the mark using double distilled water. The solution was filtered and acetone (extra grade Sarabhai Chemicals) was added to assist in preservation.

3.2.4.1.3 Test procedure

Into each of the 25 ml volumetric flask 2 ml of clear, non-haemolysed serum was taken and labelled as unknown. 1.5 ml of concentrated sulfuric acid (Merk; GR) was carefully added with gentle shaking. Into another volumetric flask labelled as blank 1.5 ml of concentrate sulfuric acid was pipetted out. One glass bead was put into each of the volumetric flasks to prevent spurting while sample were digested over a sand bath. When the contents were charred the flasks were allowed to cool and 0.5 ml of 30% hydrogen peroxide (M/S Merk's) was added to the contents and the flasks drop by drop and were reheated. The hydrogen peroxide has added repeatedly, heating as often as necessary to produce a solution, which remained clear and colourless even after heating, usually 3-4 additions were needed for each sample. Then the contents were cooled and the volume was made upto 20 ml using double distilled water.

In another 25 ml volumetric flask labelled as standard exactly 0.5 ml of iron standard solution was pipetted and 1.5 ml of concentrated sulphuric acid was added. The contents were diluted to 20 ml with distilled water. One ml of potassium persulfate was added to each flask and mixed thoroughly. Four ml of potassium thiocynate

was added later and mixed well. The optical density of the standard and unknown were read against blank in a ELICOcl-24 spectrophotometer at 540^onm.

3.2.4.1.4 Calculation

$$\frac{\text{Reading of standard}}{\text{Reading of unknown}} \times 0.05 \times \frac{100}{2} = \text{ug of iron per 100 ml of serum}$$

In the event blank, unknown and standard tubes were read against a tube containing distilled water set at zero, the reading of the blank or control was subtracted from both standard and unknown.

$$\frac{25}{\text{corrected reading of standard}} \times \text{corrected reading of unknown} = \text{ug of iron per 100 ml serum}$$

3.2.4.2 Estimation of blood glucose

The glucose content of blood was estimated as per the method of Folin and WU (1920) described by Oser (1965) the procedure was as follows.

3.2.4.2.1 Preparation of reagents

Alkaline copper solution was prepared by dissolving 40 g of pure anhydrous sodium carbonate (BDH, Analar) in 400 ml of double distilled water in a litre flask to this 7.5 g of tartaric acid (BDH, Analar) was added and mixed well to dissolve. The volume was made upto one

litre with double distilled water, after dissolving 4.5 g of copper sulphate (Sarabhai Chemicals, GR).

Sulphuric acid N/12 solution was prepared by addition of 2.5 ml of concentrated sulphuric acid (Sarabhai Chemicals, GR) to a litre of distilled water.

Ready to use solution of phosphomolybdic acid 10% sodium tungstate and standard glucose containing 10 mg of glucose per ml (M/S Glaxo Chemicals BDH) were used.

3.2.4.2.2 Test procedure

For preparation of the protein free filtrate 1 ml of blood was added slowly into a mixture of 8 ml of N/12 sulphuric acid and 1 ml of 10% sodium tungstate into a test tube. Mix well the test tube and allowed to stand for 10 minutes at room temperature. Then it was filtered through whatman No 1 filter paper. Into a set of Folin WU sugar tubes labelled as blank, unknown and standard 2 ml of water, 2 ml of protein free filtrate and 2 ml of working standard sugar 0.2 mg/ml solutions were pipetted out. Exactly 2 ml of alkaline copper solution was added to all the tubes and were transformed to a rapidly boiling water bath, heated for 8 minutes, then cooled under running tap water. To each tube 2 ml of phosphomolybdic

acid was added. After one minute distilled water was added upto 25 ml mark and mixed well.

The optical density of standard and unknown were read against blank in systronic model III photoelectric colorimeter at 420 mu, using wide range blue filter.

3.2.4.2.3 Calculation

$$\frac{\text{O.D of unknown}}{\text{O.D. of standard}} \times 0.4 \times \frac{100}{2} = \text{mg of glucose per 100 ml of blood}$$

3.2.5 Clinical trials

A total number of 13 clinical crossbred animals which are presented at veterinary Polyclinic, Chittoor, exhibiting high fever (103-107^oF) anorexia, enlargement of superficial lymphnodes and blood smears positive for theileria were randomly divided into two groups.

Fifteen animals which were healthy and negative for blood protozoa were taken as healthy controls. Haematological, biochemical observations in them were recorded.

3.2.5.1 Treatment with Buparvaquone

In group A all the clinical crossbred animals are given one deep intramuscular injection of Buparvaquone

(M/S Beecham Laboratories, UK) with the chemical name of 2-hydroxy-3 (Trans-4-butylcyclo-hexyl) methyl 1-4-naphthoquinone which contain 50 mg of the above compound per milli litre was given at the rate of 1 ml per 20 kg body weight (i.e. 2.5 mg/kg) of Buparvaquone as a treatment.

3.2.5.2 Treatment with oxytetracycline long acting and chloroquine phosphate

All the ailing animals in group B were treated with Oxyvet LA (Sarabhai Chemicals, Baroda) at a dose rate of 20 mg/kg body weight as a deep intramuscular injection and Lariago (IPCA Laboratories Ltd., Bombay) at the rate of 15 ml, 10 ml, 5 ml on three consecutive days. Blood samples were collected after the blood smear of the animal become negative for theileria along with alleviation of clinical symptoms.

The owners were advised to keep the animals preferably under hygienic conditions of management. Animals of both in the treated groups were kept under observation and clinical examination for 20 days. The biochemical and haematological examination of blood was carried out on the 12th and 20th day of post infection.

The efficacy of the drug was recorded on the basis of number of animals found free of infection as determined

by blood smear examinations and percentage reduction of parasitaemia of different post treatment levels.

3.2.6 Statistical analysis

Statistical analysis was carried out using the procedure as prescribed as per Snedecor and Cochran (1967). The mean and standard error of all the groups of animals for each parameter were calculated. The control values of different parameters were compared to those of before and after treatment values using student 't' test.

CHAPTER IV

4. RESULTS

4.1 INCIDENCE

A perusal of the case records and out patient registers of four hospitals i.e., Veterinary Polyclinic (VPC), Chittoor; City Veterinary Hospital, Tirupati; College Hospital, Tirupati and Ambulatory Clinic, Thondawada for the years 1986 to 1991 revealed that out of a total of 62018 white cattle admitted for treatment 590 were cases of theileriosis giving an overall incidence of 0.95% among the sick animals presented for treatment in all hospitals. The records of two organised farms i.e., Cattle farm, Lam, Guntur and Indo-Swiss Project, Visakhapatnam for the same period i.e., 1986 to 1991 revealed the overall incidence of theileriosis as 4.56%. The incidence of theileriosis institutionwise and yearwise are presented in tables 1 to 6 and 9 Figure 1.

4.1.1 Yearwise incidence

The yearwise incidence of theileriosis in all the four hospitals and two organised farms from the years 1986 to 1991 was presented in table 1 to 4 and 6, 7 respectively, Figures 1 and 2.

4.1.1.1 Yearwise incidence in clinics

Analysis of the data with respect to different years revealed no incidence of theileriosis among the indigenous cattle presented for treatment at all the centres during the period from 1986 - 91 except Veterinary Polyclinic, Chittoor which recorded an incidence of 2.68%, 0.42%, 2.96%, nil, 3.7% and 7.38% respectively for the years 1986, 87, 88, 89, 90 and 91.

During the year 1986 the incidence of theileriosis as calculated against total number of white cattle, crossbred cattle, crossbred cattle with pyrexia and total number of white cattle with pyrexia attended for treatment was 0.79%, 1.57%, 15.86% and 10.64% at VPC, Chittoor, 0.04%, 0.19%, 8.33% and 4.54% at City Veterinary Hospital, Tirupati 0.29%, 1.85%, 27.27% and 9.37% at College Hospital, Tirupati, 0.096%, 0.23%, 11.11% and 5.55% for Ambulatory Clinic, Thondawada.

During the year 1987 the incidence of theileriosis with respect to total number of cases presented was 1.79%, 0.13% and 0.25% at VPC, Chittoor; City Veterinary Hospital, Tirupati and the Ambulatory Clinic, Thondawada respectively. Among crossbred animals with pyrexia the incidence during 1987 was maximum of 20% at VPC, Chittoor followed by 11.76% at Ambulatory Clinic, while no incidence was recorded at College Hospital, Tirupati.

Table 1: Yearwise incidence of theileriosis among animals presented for treatment at Veterinary Polyclinic, Chittoor from 1986 to 1991.

Year	Total Number of	Theileria +ve cases % Incidence of theileriosis with relate to													
		White cattle	Cross bred	Indi- genous cattle	CB with pyrexia	White cattle	Cross bred	Indi- genous cases	Total White cattle	CB with pyrexia	White cattle	Cross bred	Indi- genous cases	CB with pyrexia	Total
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															

1986	5090	2292	149	227	376	36	4	40	0.79	1.57	2.68	15.86	10.64		
1987	4806	2592	235	425	660	85	1	86	1.79	3.28	0.42	20.00	13.04		
1988	5182	2824	270	398	668	65	8	73	1.41	2.3	2.96	16.33	10.94		
1989	5011	2485	259	457	716	54	0	54	1.08	2.17	0.0	11.82	7.54		
1990	4528	2264	216	332	548	84	8	92	2.03	3.71	3.70	25.30	16.74		
1991	4856	2890	149	442	591	148	11	159	3.27	5.12	7.38	33.48	26.94		

Grand Total	29473	15347	1278	2281	3559	472	32	504	1.71	3.07	2.50	20.69	14.14		

Table 2: Yearwise incidence of theileriosis among animals presented for treatment at City Veterinary Hospital, Tirupati from 1986 to 1991.

Years	Total Number of					Positive cases		% Incidence of theileriosis with relate to			
	White cattle	Cross bred cattle	Indi- genous cattle with pyrexia	Cross bred cattle with pyrexia	White cattle with pyrexia	Crossbred	Total	White cattle	Cross bred cattle	Crossbred cattle with pyrexia	White cattle with pyrexi
	2	3	4	5	6	7	8	9	10	11	12
1986	2241	521	10	12	22	1	1	0.04	0.19	8.33	4.54
1987	2365	701	25	49	74	3	3	0.13	0.43	6.12	4.05
1988	3506	927	8	11	19	0	0	0.0	0.0	0.0	0.0
1989	4119	864	18	29	47	4	4	0.1	0.46	13.79	8.51
1990	4779	1003	32	36	68	6	6	0.12	0.60	16.66	8.82
1991	4509	941	42	34	76	5	5	0.11	0.53	14.70	6.58
Grand Total	21519	4957	135	171	306	19	19	0.09	0.38	11.11	6.20

NB: There were no positive cases among indigenous cattle.

Table 3: Yearwise incidence of theileriosis among animals presented for treatment at College Hospital, Tirupati from 1986 to 1991.

Years	Total Number of					Positive cases		% Incidence of theileriosis with relate to			
	White Cattle	Cross bred cattle	Indi- genous cattle with pyrexia	Cross bred cattle with pyrexia	White cattle with pyrexia	Crossbred	Total	White cattle	Cross bred cattle	Crossbred cattle with pyrexia	White cattle with pyrexi
	2	3	4	5	6		8	10	11	12	
1986	1016	162	21	11	32	3	3	0.29	1.85	27.27	9.37
1987	904	37	3	--	3	0	0	0.0	0.0	0.0	0.0
1988	893	79	29	2	31	2	2	0.22	2.53	100.00	6.45
1989	780	110	19	7	26	2	2	0.26	1.82	28.57	7.69
1990	823	81	21	15	36	7	7	0.85	8.64	46.67	19.44
1991	987	264	16	42	58	22	22	2.23	8.33	52.38	37.93
Grand Total	5403	733	109	77	186	36	36	0.67	4.91	46.75	19.35

NB: No positive case was encountered in indigenous cattle.

Table 4: Yearwise incidence of theileriosis among animals presented for treatment at Ambulatory Clinic, Thondawada from 1986 to 1991.

Years	Total Number of					Positive cases		% Incidence of theileriosis with relate to			
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	Cross bred cattle with pyrexia	White cattle with pyrexia	Crossbred	Total	White cattle	Cross bred cattle	Crossbred cattle with pyrexia	White cattle with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12
1986	1033	440	9	9	18	1	1	0.09	0.23	11.11	5.55
1987	809	270	9	17	26	2	2	0.25	0.74	11.76	7.77
1988	1108	480	29	40	69	7	7	0.63	1.46	17.50	10.14
1989	1011	436	17	36	53	12	12	1.19	2.75	33.33	22.64
1990	806	298	5	19	24	4	4	0.50	1.34	21.05	16.67
1991	856	365	7	29	36	5	5	0.58	1.36	17.24	13.89
Grand Total	5623	2289	76	150	226	31	31	0.55	1.35	20.67	13.72

NB: No positive case was encountered in indigenous cattle.

Table 5: Overall yearwise incidence of theileriosis among animals presented for treatment in various hospitals from 1986 to 1991.

Year	Total Number of				Theileria +ve cases				% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred cases	Indigenous cases	Total cases	White cattle	CB cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1986	9380	3415	189	259	448	41	4	45	0.48	1.20	2.12	15.83	10.04
1987	8884	3600	272	491	763	90	1	91	1.02	2.5	0.37	18.33	11.93
1988	10689	4310	336	451	787	74	8	82	0.77	1.72	2.38	16.41	10.42
1989	10921	3895	313	529	842	72	0	72	0.66	1.85	0.0	13.61	8.55
1990	10936	3646	274	402	676	101	8	109	0.1	2.77	2.92	25.12	16.12
1991	11208	4460	214	547	761	180	11	191	1.7	4.04	5.14	32.91	25.10
Grand Total	62018	23326	1598	2679	4277	558	32	590	0.95	2.39	2.00	20.83	13.79

Fig.1 OVERALL YEARWISE INCIDENCE OF THEILERIOSIS IN VARIOUS HOSPITALS DURING 1986 TO 1991

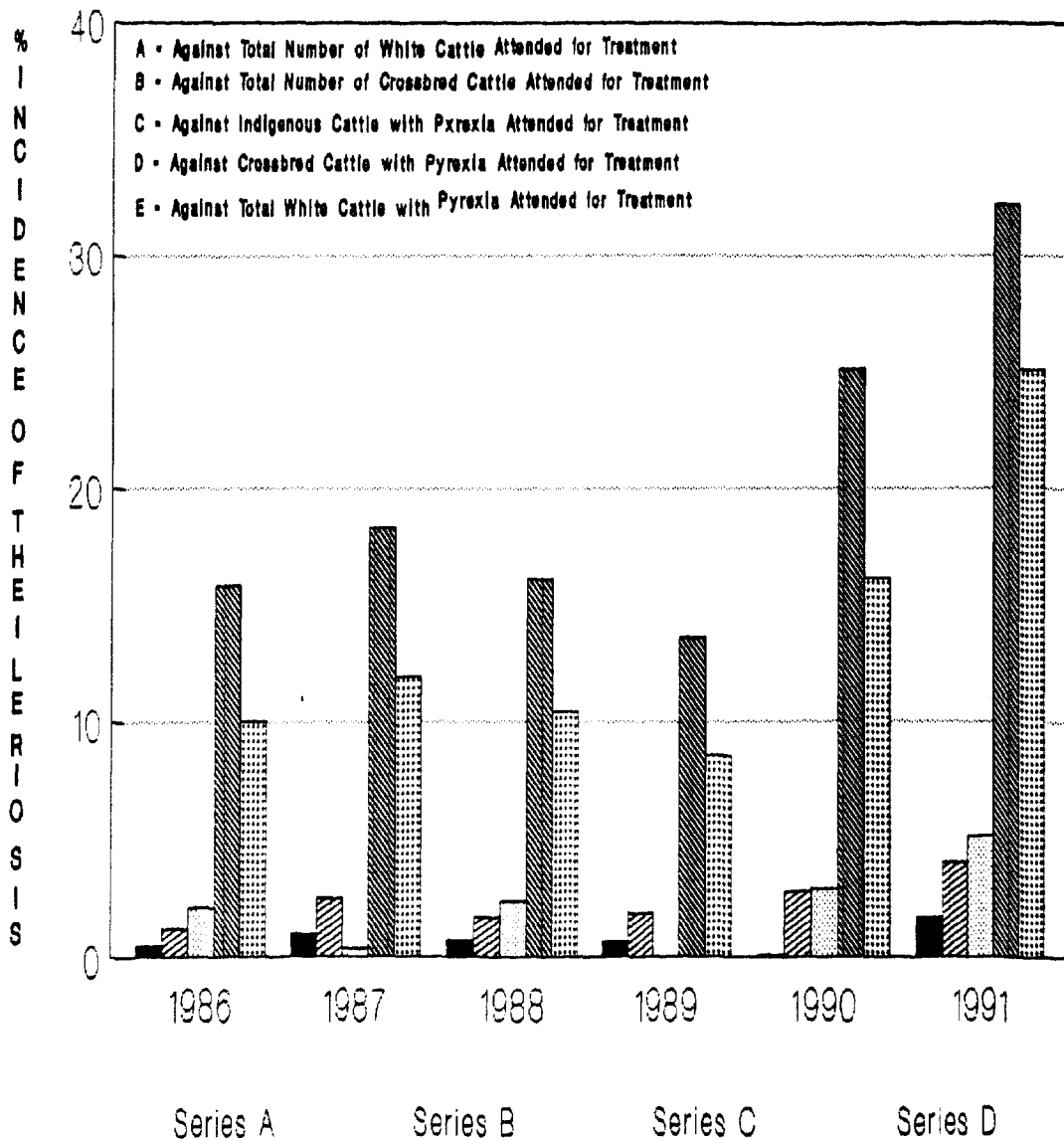


Table 6: Yearwise incidence of theileriosis in cattle farm, Lam, Guntur from 1986 to 1991.

Years	Total No. of		Theileria positive cases identified in the farm (crossbred)*	% Incidence of theileriosis with relate to	
	White cattle present in the farm	Crossbred cattle present in the farm		White cattle present in the Farm	Crossbred cattle present in the Farm
					6
1986	594	184	1	0.17	0.54
1987	478	73	72	15.06	98.63
1988	556	183	0	0.00	0.00
1989	428	158	69	16.12	43.67
1990	538	186	7	1.30	3.76
1991	691	391	0	0.00	0.00
Average	547.5	195.83	24.83	4.56	12.6

* There was no incidence in the indigenous cattle.

Table 7: Yearwise incidence of theileriosis in Indo-Swiss Project, Visakhapatnam from 1986 to 1991.

Years	Total No. of			% Incidence of theileriosis with relate to	
	White cattle present in the Farm	Crossbred cattle present in the Farm	Theileria positive cases identified in the farm (crossbred)*	White cattle present in the Farm	Crossbred cattle present in the Farm
1	2	3	4	5	6
1986	325	133	33	10.15	24.81
1987	335	92	51	15.22	55.43
1988	310	119	8	2.58	6.72
1989	331	180	-	0.00	0.00
1990	390	245	-	0.00	0.00
1991	311	214	-	0.00	0.00
Average	333.67	163.83	15.33	4.59	9.36

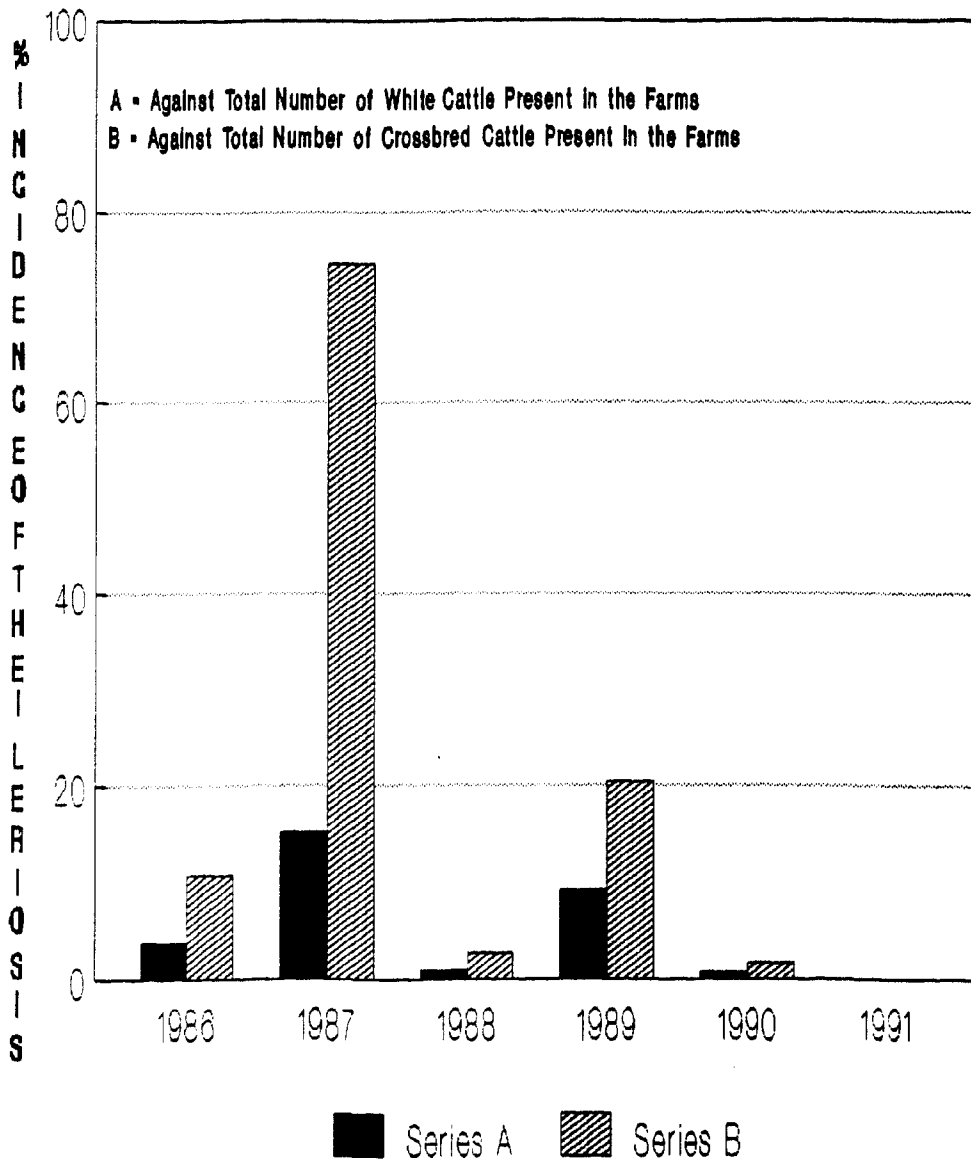
* There was no incidence in the indigenous cattle

Table 8: Overall yearwise incidence of theileriosis in both organised farms from 1986 to 1991.

Years	Total No. of			% Incidence of theileriosis with relate to	
	White cattle present in the Farms	Crossbred cattle present in the Farms	Theileria positive cases identified in the Farms (crossbred)*	White cattle present in the Farms	Crossbred cattle present in the Farms
1	2	3	4	5	6
1986	919	317	34	3.7	10.73
1987	813	165	123	15.13	74.55
1988	866	302	8	0.92	2.65
1989	759	338	69	9.09	20.41
1990	928	431	7	0.75	1.62
1991	1002	605	-	0.00	0.00
Average	881.16	359.67	40.17	4.56	11.17

* There was no incidence in the indigenous cattle

Fig.2 OVERALL YEARWISE INCIDENCE OF THEILERIOSIS IN THE ORGANISED FARMS DURING 1986 TO 1991



During the year 1988 incidence of theileriosis as against total number of cattle, crossbred cattle, crossbred cattle with pyrexia and total number of white cattle with pyrexia was 1.41%, 2.3%, 16.33% and 10.93% at VPC, Chittoor, 0.22%, 2.53%, 100% and 6.45% at College hospital and 0.63%, 1.46%, 17.5% and 10.14% in Ambulatory Clinic respectively.

During the year 1989 the incidence of theileriosis in white cattle varied from 0.1% at City Veterinary Hospital to a maximum of 1.19% at Ambulatory Clinic, Among the crossbred cattle with and without pyrexia the incidence was 2.17% and 11.82%, 0.46% and 13.79%, 1.82% and 28.57%, 2.75% and 33.33% at VPC, City Veterinary Hospital, College Veterinary Hospital and Ambulatory Clinic, respectively.

In the year 1990 the incidence of theileriosis in crossbred cattle was 3.71%, 0.6%, 8.64%, 1.34% as against 25.30%, 16.66%, 46.67% and 21.05% in crossbred animal with pyrexia attending for treatment at VPC, City Veterinary Hospital, College Hospital and Ambulatory Clinic respectively.

The incidence of theileriosis was 3.27%, 5.12%, 33.48% and 26.90% in VPC, 0.11%, 0.53%, 14.7% and

6.58% in City Veterinary Hospital, 2.23%, 8.33%, 52.38% and 37.93% in College Hospital, 0.58%, 1.36%, 17.24% and 13.89% in Ambulatory Clinic with regard to the total number of white cattle, crossbred cattle, crossbred cattle with pyrexia and white cattle with pyrexia attended for treatment during the year 1991.

The overall incidence of theileriosis in white cattle, crossbred cattle, indigenous cattle with pyrexia, crossbred cattle with pyrexia and white cattle with pyrexia was 0.95%, 2.39%, 2.0%, 20.83% and 13.79% respectively (Table 5).

4.1.1.2 Yearwise incidence in farms

The yearwise incidence of theileriosis in cattle farm, Lam depicted in table 6. In this farm the population of white cattle varied from 428 during 1989 to 691 in 1991 with an average of 547.5 per year. There was no incidence of theileriosis in any indigenous cattle during any year under report. Among the crossbred cattle as many as 72 out of 73 animals were affected with a percentage of incidence of 98.63% during the year 1987, while during the next year i.e., 1988 the incidence became nil. During the year 1989 the incidence in crossbred cattle was 43.67% which declined to 3.76% during 1990 and was free of this disease for the year 1991.

The incidence of theileriosis for the years from 1986-91 at Indo-Swiss Project, Visakhapatnam has been presented in table 7 the total number of white cattle varied from 310 to 390 while the crossbred population varied from 92 to 245 during different years. The maximum percentage of incidence in crossbred cattle during 1987 was i.e., 55.43%. During the previous year i.e., 1986 the incidence was at 24.81%. For the year 1988 the incidence declined to 6.72% and it was free from theileriosis during the subsequent three years. The combined picture of the incidence of theileriosis in both the farms presented in table 8 and Fig 2. There was no incidence in both farms in indigenous cattle and also in crossbred cattle during 1991. In the crossbred cattle the maximum incidence of 74.55% was recorded during 1987 while it was 2.65% and 20.41% during the subsequent 2 years followed by 1.62% for the year 1990.

4.1.2 Centrewise incidence

The centrewise incidence for the four hospitals and two organised farms are presented in tables 9, 6 and 7.

4.1.2.1 Centrewise incidence in clinics

Centrewise incidence of theileriosis at Veterinary Polyclinic, Chittoor; City Veterinary Hospital, Tirupati;

Table 9: Centrewise incidence of theileriosis among animals presented for treatment at various hospitals during 1986 to 1991.

Centre	Total Number of				Theileria +ve cases				% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred cattle with pyrexia	Indigenous cattle with pyrexia	Total cases	White cattle	CB cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
	2	3	4	5	6	7	8	9	10	11	12	13	15
Vety. Poly Clinic, Chittoor.	29473	15347	1278	2281	3559	472	32	504	1.71	3.07	2.5	20.60	14.16
City Vety. Hospital, Tirupati.	21519	4957	135	171	306	19		19	0.09	0.38	0.0	11.11	6.2
College Hospital, Tirupati.	5403	733	109	77	186	36	0	36	0.67	4.91	0.0	46.75	19.35
Ambulatory Clinic, Thondawada.	5623	2289	76	150	226	31	0	31	0.55	1.35	0.0	20.67	13.72
Grand Total of all the Hospitals.	62018	23326	1598	2679	4277	558	32	590	0.95	2.39	2.0	20.93	13.79

College Hospital, Tirupati and Ambulatory Clinic, Thondawada during the period 1989-91 is presented in table 9. The percent of theileriosis as calculated against total number of white cattle, crossbred cattle and number of crossbred cattle with pyrexia attended for treatment was 1.71%, 3.07%, 20.69% and 14.16% in Veterinary Polyclinic, Chittoor, 0.09%, 0.38%, 11.11% and 6.2% in City Veterinary Hospital, Tirupati; 0.67%, 4.91%, 46.75% and 19.35% in College Hospital, Tirupati; 0.55%, 1.35%, 20.67% and 13.72% in Ambulatory Clinic, Thondawada respectively. As can be seen from table 9 there was no incidence of theileriosis among indigenous cattle at all the clinics except polyclinic. The maximum incidence of 1.71% for white cattle was recorded at VPC, Chittoor while it was minimum with respect to City Veterinary Hospital 0.09%. As regards incidence of theileriosis in crossbred cattle and crossbred cattle with pyrexia maximum values were attained in College Clinic 4.91% and 46.75% respectively. The average percent of theileriosis in crossbred cattle with fever varied from 11-21% in the remaining three clinics.

4.1.2.2 Centrewise incidence in farms

Centrewise incidence of theileriosis at cattle farm, Lam, Guntur and Indo-Swiss Project, Visakhapatnam during

the period 1986-91 is presented in table 6 and 7. When the percent of theileriosis as calculated against average white cattle, crossbred population present in the farms it was found to be 4.56% and 12.6% in cattle farm, Lam at Guntur; 4.59% and 9.36% in Indo-Swiss Project, Visakhapatnam respectively. As can be seen from the tables there was no incidence of theileriosis recorded in the indigenous cattle present in the both farms.

4.1.3 Monthwise incidence

In order to calculate the monthwise incidence the number of cases during a particular month of individual years and cumulative of all the 6 years was added separately with respect of each institution (Tables 10-15, Figures 3 and 4). The data were also analysed in detail with respect of monthwise occurrence of theileriosis at various hospitals and farms separately.

4.1.3.1 Monthwise incidence in clinics

In indigenous cattle with pyrexia the incidence could be recorded only during July to September while the incidence in crossbred cattle was maximum during November (42.85%) followed by May (31.82%) in 1986. But there was no incidence during February, June and July.

During the year 1987 in the hospitals the highest incidence was recorded during July (2.83%), July (6.69%)

hospitals during 1986.

Months	Total Number of				Theileria +ve cases			% incidence of theileriosis with relate to					
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred cattle with pyrexia	Indigenous cases	Total cases	White cattle	CB cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
	2	3	4	5	6	7	8	9	10	11	12	13	14
January	776	250	13	28	41	4	0	4	0.52	1.60	0.00	14.29	9.76
February	751	212	17	11	28	0	0	-	0.00	0.00	0.00	0.00	0.00
March	786	222	19	24	43	3	0	3	0.38	1.35	0.00	12.50	6.98
April	694	223	14	10	24	2	0	2	0.29	0.90	0.00	20.0	8.33
May	756	303	8	22	30	7	0	7	0.93	2.31	0.00	31.82	23.33
June	801	350	5	17	22	0	0	0	0.00	0.00	0.00	0.00	0.00
July	755	296	11	10	21	0	2	2	0.26	0.00	18.18	0.0	9.52
August	786	323	20	31	51	3	1	4	0.51	0.93	5.00	5.88	7.84
September	758	314	11	28	39	7	1	8	1.05	2.23	9.09	25.0	20.51
October	892	395	48	60	108	11	0	11	1.23	2.78	0.00	18.33	10.19
November	752	187	13	7	20	3	0	3	0.40	1.60	0.00	42.85	15.0
December	873	340	10	11	21	1	0	1	0.11	0.29	0.00	9.09	4.76
Grand Total	9380	3415	189	259	448	41	4	45	0.48	1.20	2.12	15.83	10.04

Table 11: Monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1987.

Months	Total Number of					Theileria +ve cases			% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred	Indi- genous	Total cases	White cattle	CB cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	773	277	9	17	26	0	0	0	0.0	0.0	0.0	0.0	0.0
February	668	232	14	10	24	0	0	0	0.0	0.0	0.0	0.0	0.0
March	614	217	9	24	33	1	0	1	0.16	0.46	0.0	4.17	3.03
April	665	287	21	47	68	6	0	6	0.90	2.09	0.0	12.76	8.82
May	742	293	18	58	76	10	0	10	1.35	3.41	0.0	17.24	13.15
June	685	290	33	26	59	16	0	16	2.34	5.52	0.0	61.54	27.12
July	777	329	39	67	106	22	0	22	2.83	6.69	0.0	32.84	20.75
August	871	377	21	58	79	9	0	9	1.03	2.39	0.0	15.52	11.39
September	806	389	42	80	122	14	0	14	1.74	3.60	0.0	17.50	11.47
October	704	308	42	50	92	8	0	8	1.14	2.60	0.0	16.00	8.70
November	717	266	22	25	47	2	0	2	0.28	0.75	0.0	8.00	4.25
December	862	335	2	29	31	2	1	3	0.35	0.60	50.0	6.90	9.68
Grand Total	8884	3600	272	491	763	90		91	1.02	2.5	0.37	18.33	11.93

Table 12: Monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1988.

Months	Total Number of					Theileria +ve cases			% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred	Indigenous	Total cases	White cattle	CB cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	863	346	15	14	29	4	1	5	0.58	1.16	6.67	28.57	17.24
February	775	277	7	28	35	5	0	5	0.65	1.80	0.0	17.86	14.28
March	757	295	29	18	47	7	3	10	1.32	2.37	10.34	38.89	21.29
April	823	298	12	60	72	16	0	16	1.94	5.37	0.0	26.67	22.22
May	870	430	22	44	66	8	2	10	1.15	1.86	9.09	18.18	15.15
June	908	407	48	41	89	6	1	7	0.77	1.47	2.08	14.63	7.86
July	967	381	22	72	94	5	1	6	0.62	1.31	4.54	6.94	6.38
August	980	420	51	30	81	3	0	3	0.31	0.71	0.0	10.0	3.70
September	985	389	65	52	117	7	0	7	0.71	1.80	0.0	13.46	5.98
October	1005	413	24	42	66	3	0	3	0.30	0.73	0.0	7.14	4.54
November	919	319	33	21	54	6	0	6	0.65	1.90	0.0	28.57	11.11
December	837	335	8	29	37	4	0	4	0.48	1.19	0.0	13.79	10.81
Grand Total	10689	4310	336	451	787	74	8	82	0.77	1.72	2.38	16.41	10.42

Table 13: Monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1989.

Months	Total Number of					Theileria +ve cases				% incidence of theileriosis with relate to			
	White cattle	Cross bred cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	White bred	Cross bred	Indi- genous cases	Total	White cattle	CB cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	793	312	21	27	48	4	0	4	0.50	1.28	0.0	14.81	8.33
February	744	350	17	24	41	1	0	1	0.13	0.29	0.0	4.17	2.44
March	918	392	17	47	64	5	0	5	0.54	1.27	0.0	10.64	7.81
April	805	314	21	37	58	10	0	10	1.24	3.18	0.0	27.03	17.24
May	893	289	26	63	89	11	0	11	1.23	3.80	0.0	17.46	12.36
June	864	303	15	29	44	2	0	2	0.23	0.66	0.0	6.90	4.54
July	1009	334	32	41	73	8	0	8	0.79	2.39	0.0	19.51	10.96
August	1122	378	58	68	126	4	0	4	0.36	1.06	0.0	5.90	3.17
September	1014	397	50	62	112	11	0	11	1.08	2.77	0.0	17.74	9.82
October	910	294	23	56	79	5	0	5	0.55	1.70	0.0	8.93	6.33
November	873	284	21	32	53	0	0	0	0.0	0.0	0.0	0.0	0.0
December	976	248	12	43	55	11	0	11	1.13	4.43	0.0	25.58	20.0
Grand Total	10921	3895	313	529	842	72	0	72	0.66	1.85	0.0	13.61	8.55

Table 14: Monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1990.

Months	Total Number of					Theileria +ve cases			% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred	Indi- genous	Total cases	White cattle	CB cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	978	287	46	28	74	5	4	9	0.92	1.74	8.7	17.86	12.16
February	797	247	31	32	63	7	0	7	0.88	2.83	0.0	21.87	11.11
March	947	301	37	63	100	5	1	6	0.63	1.66	2.7	7.94	6.0
April	806	231	14	28	42	2	0	2	0.25	0.87	0.0	7.14	4.76
May	749	246	15	11	26	0	0	0	0.00	0.00	0.0	0.00	0.00
June	872	260	17	10	27	4	3	7	0.80	1.54	17.65	40.0	25.93
July	979	279	27	71	98	5	0	5	0.51	1.79	0.0	7.04	5.10
August	974	320	16	13	29	7	0	7	0.72	2.19	0.0	53.85	24.14
September	980	427	16	40	56	10	0	10	1.02	2.34	0.0	25.00	17.86
October	971	339	24	23	47	15	0	15	1.54	4.42	0.0	65.22	31.91
November	918	325	12	42	54	16	0	17	1.74	4.92	0.0	38.09	29.63
December	965	384	19	41	60	25	0	25	2.59	6.51	0.0	60.98	41.67
Grand Total	10936	3646	274	402	676	101	8	109	1.0	2.77	2.92	25.12	16.12

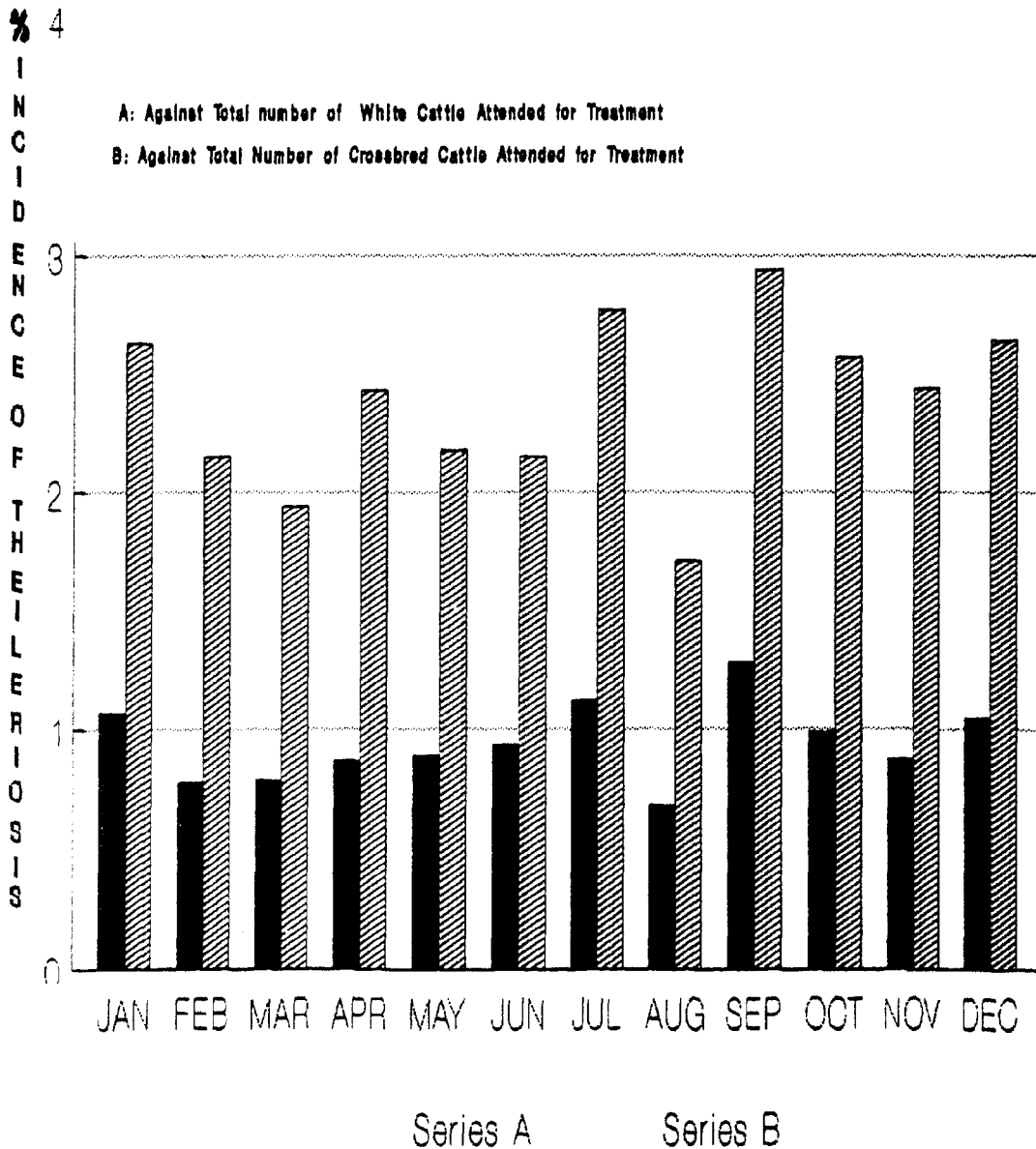
Table 15: Monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1991.

Months	Total Number of				Theileria +ve cases				% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred	Indi- genous	Total cases	White cattle	CB cattle	Indi- genous cattle with pyrexia	CB cattle with pyrexia	Total cases with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
January	768	318	25	36	61	30	1	31	4.04	9.43	4.0	83.33	50.82
February	736	266	13	36	49	21	1	22	2.99	7.89	7.69	58.33	44.89
March	903	321	9	34	43	13	1	14	1.55	4.05	11.11	38.23	32.56
April	931	336	20	39	59	5	0	5	0.54	1.49	0.0	12.82	8.47
May	801	320	8	30	38	5	0	5	0.62	1.56	0.0	16.67	13.16
June	870	344	17	60	77	14	1	15	1.72	4.06	5.88	23.33	19.48
July	1219	545	27	95	122	20	1	21	1.72	3.67	3.70	21.05	17.21
August	976	401	23	43	66	12	0	12	1.23	3.0	0.0	27.91	18.18
September	992	398	29	48	77	19	2	21	2.12	4.77	6.89	39.58	27.27
October	1047	393	13	40	53	13	0	13	1.24	3.31	0.0	32.50	24.53
November	952	380	14	55	69	16	2	18	1.89	4.21	14.28	29.09	26.09
December	1013	438	16	31	47	12	2	14	1.38	2.74	12.50	38.71	29.79
Grand Total	11208	4460	214	547	761	180	11	191	1.70	4.04	5.14	32.91	25.09

Table 16: Overall monthwise incidence of theileriosis among animals presented for treatment in various hospitals during 1986 to 1991.

Months	Total Number of				Theileria +ve cases										% incidence of theileriosis with relate to	
	Indi- CB		White		Cross Indi- Total		White CB		Indi- CB		Total		Total			
	White cross bred cattle with pyrexia	Indi- CB cross bred cattle with pyrexia	White cross bred cattle with pyrexia	Total cross bred cattle with pyrexia	White cross bred cattle with pyrexia	Total cross bred cattle with pyrexia	White cross bred cattle with pyrexia	Total cross bred cattle with pyrexia	Indi- CB cross bred cattle with pyrexia	Total cross bred cattle with pyrexia	Indi- CB cross bred cattle with pyrexia	Total cross bred cattle with pyrexia	White cross bred cattle with pyrexia	Total cross bred cattle with pyrexia		
2	3	4	5	6	7	8	9	10	11	12	13	14	15			
January	4951	1790	129	150	279	47	6	53	1.07	2.63	4.65	31.33	18.99			
February	4471	1584	99	141	240	34	1	35	0.78	2.15	1.01	24.11	14.58			
March	4925	1748	120	210	330	34	5	39	0.79	1.94	4.17	16.19	11.81			
April	4724	1689	102	221	323	41	0	41	0.87	2.43	0.0	18.55	12.69			
May	4811	1881	97	228	325	41	2	43	0.89	2.18	2.06	17.98	13.23			
June	5000	1954	135	183	318	42	5	47	0.94	2.15	3.70	22.95	14.78			
July	5706	2164	158	356	514	60	4	64	1.12	2.77	2.53	16.85	12.45			
August	5709	2219	189	243	432	38	1	39	0.68	1.71	0.53	15.64	9.03			
September	5535	2314	213	310	523	68	3	71	1.28	2.94	1.41	21.93	13.57			
October	5529	2142	174	271	445	55	0	55	0.99	2.57	0.00	20.29	12.36			
November	5131	1761	115	182	297	43	2	45	0.88	2.44	1.74	23.62	15.15			
December	5526	2080	67	184	251	55	3	58	1.05	2.64	4.48	29.89	23.11			
Grand Total	62018	23226	1598	2679	4277	558	32	590	0.95	2.39	2.00	20.83	13.79			

**FIG 3. OVERALL MONTHWISE INCIDENCE OF THEILERIOSIS
IN HOSPITALS DURING 1986 TO 1991**



December (50%), June (61.54%) and June (27.12%) with relation to total number of cattle, crossbred cattle, indigenous cattle with pyrexia, crossbred cattle with pyrexia and white cattle with pyrexia attended for treatment these values are depicted in table 11. No incidence of theileriosis in indigenous cattle was recorded during January to November while there was 50% incidence during December.

The cumulative data of all the hospitals for the year 1988 when analysed monthwise revealed highest incidence of theileriosis with regard to total number of cattle, crossbred cattle, indigenous cattle with pyrexia, crossbred cattle with pyrexia and white cattle with pyrexia, recorded as 1.94% during April, 5.37% during April, 10.34% during March, 38.89% during March and 22.22% during April respectively (vide table 12).

During 1989 a total of 10921 white cattle were presented of which 3895 were crossbred. The incidence of theileriosis in indigenous cattle was nil while in crossbred cattle it was highest in December (4.43%) and nil during November with an average incidence of 1.85%.

In the year 1990 there was no incidence of theileriosis in indigenous cattle during February, April, May and July to December. In the crossbred cattle the

highest incidence was recorded during December 6.51% the remaining values are presented in table 14.

The highest incidence of theileriosis in crossbred cattle and crossbred cattle with pyrexia during 1991 was recorded in January as 9.43% and 83.33% respectively while in indigenous cattle with pyrexia an incidence of 14.28% was recorded during November.

The overall monthwise incidence of theileriosis in all the hospitals during 1986 to 1991 in white cattle, crossbred cattle, indigenous with pyrexia, crossbred with pyrexia and white cattle with pyrexia the highest incidence recorded during September (1.28%), September (2.94%), January (4.65%), January (31.33%) and December (23.10%) respectively table 16 and Figures 3 and 4.

4.2.3.2 Monthwise incidence in farms

The monthwise incidence of theileriosis at both farms, during the year 1986 the total population of white cattle and crossbred cattle were 919 and 317 respectively. Out of the crossbred cattle only one clinical case of theileriosis was recorded during February and 33 cases during September giving a percentage incidence of 3.59% and 10.41% regard white cattle and crossbred cattle respectively.

For the year 1987, the highest monthwise incidence was recorded during April giving 6.52% and 32.12% regard to white cattle and crossbred cattle. No incidence was recorded during January, March and August to November in either of the Farms.

The incidence of theileriosis recorded as 0.92% and 2.65% only during July month against 866 total white cattle and 302 total crossbred cattle respectively present during the year 1988.

During the year 1989, the total population of white cattle and crossbred cattle were 759 and 338 respectively. The incidence of theileriosis was recorded only during the month of September to November. The highest incidence was during September i.e., 5.8% and 13.02% respectively against white cattle and crossbred cattle population.

The population of white cattle and crossbred cattle was 928 and 431 respectively for the year 1990. At both farms the clinical cases of theileriosis could only be recorded during July and August months with 1 and 6 cases respectively giving an incidence of 0.11% and 0.23%, 0.65% and 1.93% against white cattle and crossbred cattle. There was no incidence of theileriosis recorded 1991 in either of the farms.

Over all monthwise incidence of theileriosis in both farms from 1986 to 1991 revealed the highest incidence during September (1.80% and 4.96%) and least during January and March (0.0%) against 857 average white cattle and 310.6 average crossbred cattle present in the both farms.

4.1.4 Seasonwise incidence

4.1.4.1 Seasonwise incidence in clinics

The seasonwise incidence in various hospitals has been presented in table 17 and Fig 5. The highest incidence of theileriosis was observed during rainy season (1.01%), rainy season (2.49%), summer season (2.64%), winter season (27.63%) and winter season (17.57%) with regard to total number of white cattle, crossbred cattle, indigenous cattle with pyrexia, crossbred with pyrexia and white cattle with pyrexia attended for treatment. The percent incidence of theileriosis in crossbred cattle with pyrexia varied from 16.65-18.82% during rainy and summer seasons, while it was maximum (27.63%) during winter.

4.1.4.2 Seasonwise incidence in farms

Seasonwise incidence of theileriosis in the two farms combinedly is being presented in table 18 and Fig 6.

Table 17: Seasonwise incidence of theileriosis among animals presented for treatment in various hospitals during 1986 to 1991.

Season	Total Number of				Theileria +ve cases				% incidence of theileriosis with relate to				
	White cattle	Cross bred cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia	Cross bred cattle with pyrexia	Indigenous cases	Total cases	White cattle	CB cattle	Indigenous cattle with pyrexia	CB cattle with pyrexia	White cattle with pyrexia
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Summer (March to June)	19460	7270	454	834	1288	157	12	169	0.87	2.16	2.64	18.82	13.12
Rainy (July to October)	22477	8841	734	1321	2055	220	8	228	1.01	2.49	1.09	16.65	11.09
Winter (November to February)	20633	7954	350	532	885	147	8	155	0.75	1.94	2.29	27.63	17.57

Fig.5 SEASONWISE INCIDENCE OF THEILERIOSIS AMONG ANIMALS PRESENTED FOR TREATMENT IN VARIOUS HOSPITALS DURING 1986 TO 1991

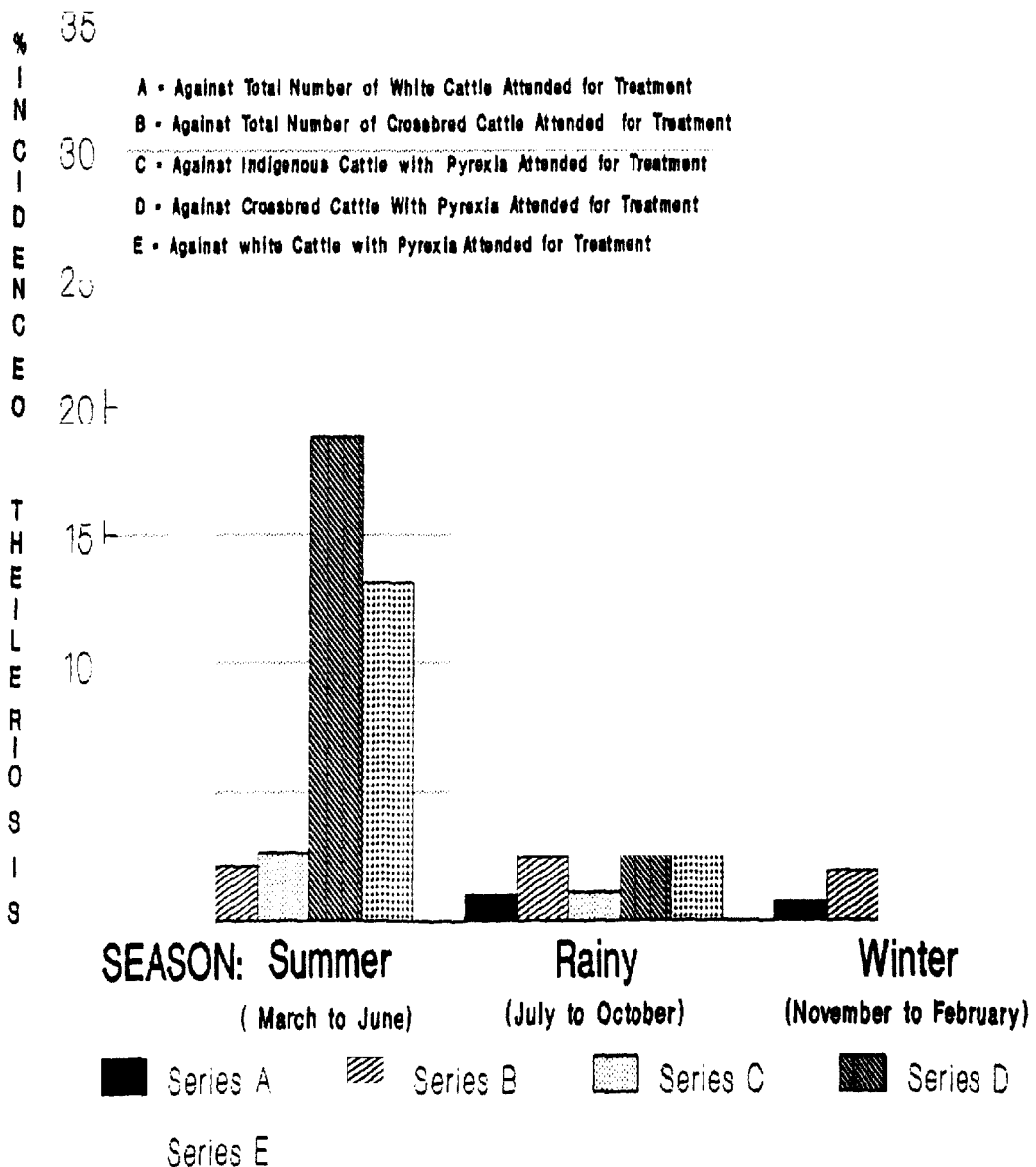
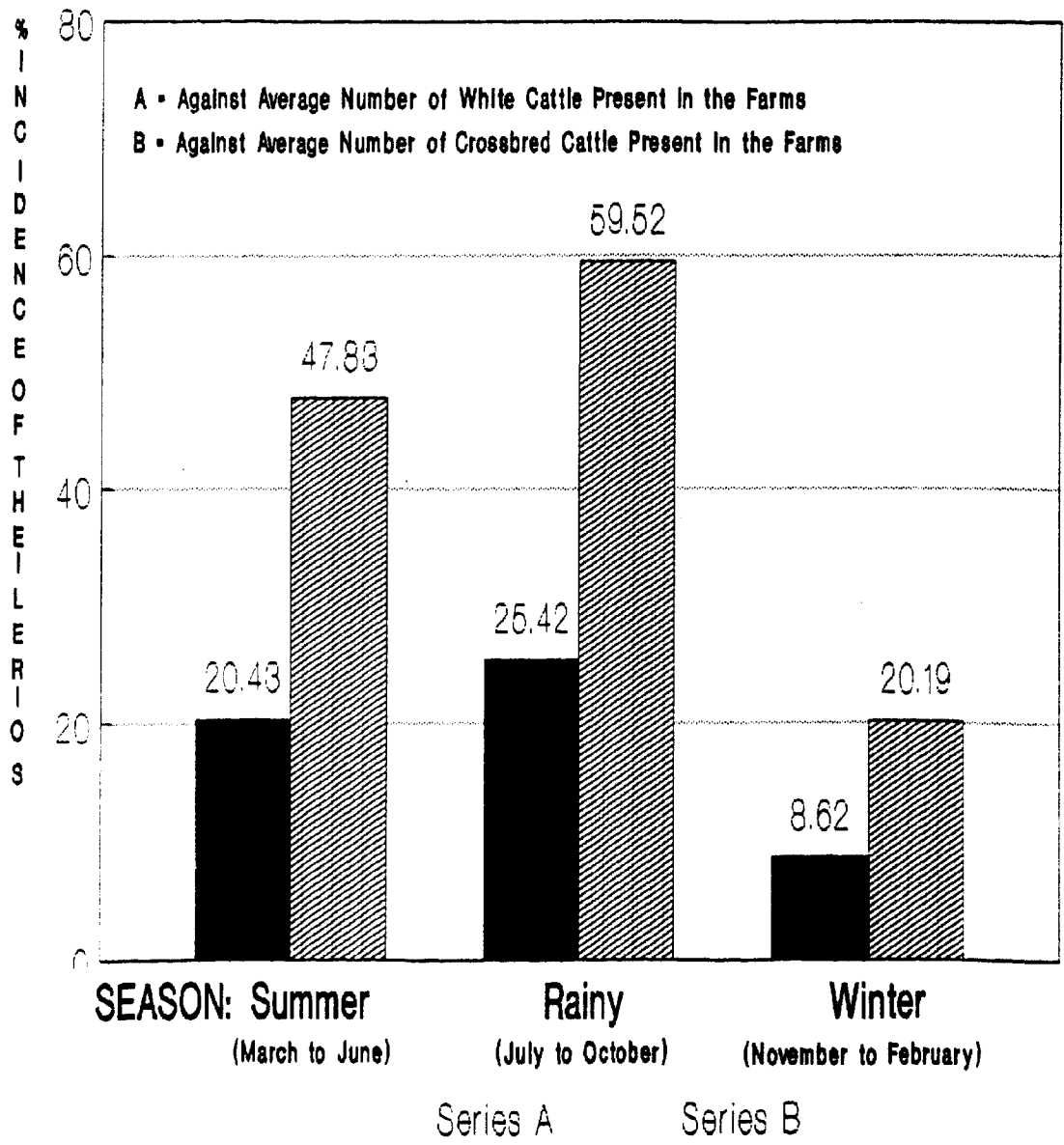


Table 18; Seasonwise incidence of theileriosis in various organised farms during 1986 to 1991

Season	Average No. of		Theileria positive cases identified in the farms (crossbred)	% incidence of theileriosis with relate to	
	White cattle present in the farms	Crossbred cattle present in the farms		Average No.of	
				White cattle present in the farms	Crossbred cattle present in the farms
Summer (March to June)			90	20.43	47.83
Rainy (July to October)	440.59	188.17	112	25.42	59.52
Winter (November to February)			38	8.62	20.19

Fig.6 SEASONWISE INCIDENCE OF THEILERIOSIS AMONG AVERAGE NUMBER OF ANIMALS PRESENT IN THE FARMS DURING 1986 TO 1991



The highest incidence was recorded during rainy season 25.42% and 59.42% with respect to mean white cattle and crossbred cattle present in the farms. Lowest incidence was observed during winter season 8.62% for white cattle and 20.19% for the crossbred cattle.

4.1.5 Incidence in different breeds

Breedwise distribution of theileriosis was presented in table 19.

Out of total 79 calves affected 71 were crossbreds (8.54%) and 8 were indigenous calves (0.96%). Out of 735 cows positive for theileria only 19 were non-discrpt. Among the 716 crossbred cows 583 were Jersey, 105 HF crosses, and 28 intersee crosses giving 70.16%, 12.64% and 3.37% respectively among total theileria positive cases. A total of 17 bulls/oxen affected with theileria of which twelve were crossbred (1.44%) and 5 indigenous (0.6%). The over all average of all the centres i.e., 4 hospitals and 2 farms revealed 96.15% cases were crossbreds and 3.85% were indigenous cattle of the 831 positive cases.

4.1.5.1 Breedwise incidence in clinics

Out of 590 theileria positive cases recorded in four hospitals 558 (94.58%) were in crossbreds and only 32 (5.42%) were indigenous. Of the 558 crossbred animals

Table 19: Breedwise percentage distribution among theileria positive cases in various hospitals and organised farms during 1986 to 1991

	Crossbred				Indigenous					
	Calves		Cows		Bulls/Oxen		Calves Cows Bulls/Oxen			
	Jersey	HF	Inter-see							
Hospitals (Total 590 +ve cases)	56 (9.49%)	441 (74.75%)	51 (8.64%)	Nil	10 (1.69%)	558 (94.58%)	8 (1.36%)	19 (3.22%)	5 (0.85%)	32 (5.42%)
Farms (Total 241 +ve cases)	15 (6.22%)	142 (58.92%)	54 (22.4%)	28 (11.62%)	2 (0.83%)	241 (100%)	Nil	Nil	Nil	Nil
Overall Incidence (83½ +ve Cases)	71 (8.54%)	583 (70.16%)	105 (12.64)	28 (3.37%)	12 (1.44%)	799 (96.15%)	8 (0.96%)	19 (2.29%)	5 (0.6%)	32 (3.85%)

Figures in parenthesis indicates percent incidence of theileriosis

56 were calves constituting 9.49%. Among the cows 441 Jersey cross (74.75%) 51 HF crosses (8.64%). Among the indigenous 8 were (1.36%) calves, 19 (3.22%) cows and 5 (0.85%) bulls/oxen also affected.

4.1.5.2 Breedwise incidence in farms

In the farms a total of 241 positive cases were recorded and all the affected animals were crossbreds and no incidence was recorded in the indigenous cattle. A total 241 cases 15 calves, 142 Jersey cross, 54 HF cross cows, 28 intersee crosses and 2 bulls/oxen were affected giving a percentage of 6.22%, 58.92%, 22.41%, 11.62% and 0.83% respectively.

4.2 CLINICAL, HAEMATOLOGICAL AND BIOCHEMICAL OBSERVATION MADE ON HEALTHY ANIMALS

The results of clinical, examinations of 15 healthy crossbred cows (control group) have been presented in table 20. The mean temperature, pulse and respiration rates were $101.25 \pm 0.12^{\circ}\text{F}$, $57.73 \pm 1.15/\text{min}$ and $20.87 \pm 0.67/\text{min}$ respectively. The rumen motility for 2 minutes was 2 ± 0.14 .

The haematological and biochemical values are depicted in table 21. As can be seen the mean PCV, haemoglobin total erythrocyte count, total leucocyte count, blood glucose and serum iron values were recorded as $30.8 \pm 1.01\%$,

Table 20: Clinical observations on healthy crossbred cows (control group)

S.No.	Description of the animal Age; Breed; (cows)	Temperature °C	Pulse/min	Respira- tions/min	Rumen motility/ 2 min
1.	3½ years; Jersey cross	101.8	62	24	2
2.	6 years; Jersey cross	101.0	60	17	3
3.	6 years; Jersey cross	101.4	54	20	2
4.	2 years; Holstin Friesian cross	101.0	50	22	2
5.	6 years; Jersey cross	101.8	58	20	2
6.	5 years; Jersey cross	100.4	62	24	2
7.	3 years; Jersey cross	101.4	64	22	2
8.	4 years; Holstin Friesian cross	101.4	62	20	2
9.	6 years; Jersey cross	101.6	54	24	1
10.	6 years; Jersey cross	101.2	62	20	1
11.	2½ years; Jersey cross	101.2	56	22	2
12.	4 years; Holstin Friesian cross	100.4	58	16	2
13.	6 years; Holstin Friesian cross	100.8	60	18	2
14.	4 years; Jersey cross	101.6	52	24	3
15.	5 years; Jersey cross	101.8	52	20	2
Mean		101.25	57.73	20.87	2
+ S.E		+0.12	+1.15	+0.67	+0.14

Table 21: Haematological and biochemical observations on healthy crossbred cows

Sl.No.	PCV%	Haemoglobin g%	TEC mill/cmm	TLC X 10 ³ /cmm	Blood glucose mg%	Serum iron ug%
1.	30	11.4	5.42	10.4	40.14	125.00
2.	28	10.0	4.47	9.9	46.12	173.07
3.	30	11.2	5.53	9.85	48.23	125.00
4.	32	11.0	5.94	8.7	52.46	161.30
5.	28	9.0	4.91	8.05	44.01	117.75
6.	36	12.8	7.01	7.3	50.25	161.30
7.	38	13.0	5.17	9.4	48.23	124.40
8.	30	10.0	4.56	10.0	46.12	158.45
9.	26	10.0	4.33	7.8	48.88	158.45
10.	28	10.0	4.56	8.25	53.35	193.66
11.	28	10.0	4.26	8.70	48.88	121.26
12.	36	12.4	6.58	8.35	51.11	167.09
13.	30	10.0	4.82	8.65	48.88	117.75
14.	26	9.0	4.43	7.35	42.83	161.30
15.	36	10.8	6.92	9.85	46.64	196.66
Mean	30.8	10.71	5.26	8.84	47.74	150.83
± S.E.	±1.01	±0.32	±0.24	±0.26	±0.92	±6.98

10.70 \pm 0.32 g%, 5.26 \pm 0.24 mill/cmm, 8.84 \pm 0.26 $\times 10^3$ /cmm, 47.74 \pm 0.93 mg% and 150.83 \pm 6.98 ug% respectively.

4.2.1 Clinical, haematological and biochemical observations made on clinical cases of theileriosis

For detailed clinico-therapeutic studies on theileriosis, 13 clinical cases were selected and the clinical symptoms were recorded. In all 13 animals showed anorexia, swelling of prescapular lymphnodes, weakness, pale anaemic conjunctival mucous membranes, three lactating animals showed reduced in milk yield, two animals showed enteritis, cough was observed in 6 animals and bilateral serous nasal discharges in 3 animals.

The clinical, haematological, and biochemical values before treatment with buparvaquone i.e., (group I) and Oxyvet LA plus Lariago i.e., (group II) are presented in table 22 and 23.

When these mean values of two groups were compared against the mean values of healthy control group by two sample 't' test there was significant rise ($P < 0.01$) in temperature, pulse, respiration rates in both groups. Where as significant fall in ($P < 0.01$) rumen motility, PCV, haemoglobin, blood glucose and serum iron in both groups. There was significant fall in ($P < 0.01$) and

Table 22: Clinical, haematological, and biochemical values before treatment in theileria affected crossbred cows belonging to Group I

S.No.	Case No.	Breed age (cows)	Temp. o _F	Pulse /min	Respiration /min	Rumen motility /2 min	PCV %	Hae- moglo- bin g%	Total eryth- rocyte count mill/ cmm	Total leuco- cyte count X10 ³ /cmm	Blood glucose mg%	Serum iron ug%
1.	26	Holstin Friesian Cross 5 yrs	104.0	86	24	Nil	24	7.0	4.33	10.95	38.02	78.52
2.	74	Holstin Friesian Cross 6 yrs	103.8	68	30	Nil	19	5.0	3.52	4.0	40.01	114.43
3.	134	Jersey cross 5 yrs	104.0	65	32	Nil	20	6.0	4.17	4.25	40.01	117.75
4.	235	Holstin Friesian Cross 3 yrs.	107.0	78	36	1	21	5.5	3.85	13.85	42.85	38.46
5.	678	Jersey cross 6 yrs	105.0	66	30	Nil	18	7.0	4.16	5.65	37.67	83.94
6.	4320	Jersey cross 3 yrs	106.0	68	28	1	18	6.0	3.42	5.35	40.29	81.52
7.	6025	Holstin Friesian Cross 4 yrs.	106.0	98	26	1	18	5.0	3.97	11.8	35.14	86.52
Mean			105.11	75.57	29.43	0.43	19.71	5.93	3.92	7.98	39.14	85.88
±S.E			±0.47	±4.72	±1.49	±0.20	±0.84	±0.32	±0.13	±1.54	±0.93	±9.95

Table 23: Clinical, haematological and biochemical values before treatment in theileria affected crossbred cows belonging to Group II

S.No.	Case No.	Breed age (cows)	Temp. $^{\circ}$ F	Pulse /min	Respi- ration /min	Rumen moti- lity /2 min	PCV %	Hae- moglo- bin g%	Total eryth- rocyte count mill/ cmm	Total leuco- cyte count $\times 10^3$ /cmm	Blood glucose mg%	Serum iron ug%
1.	116	Jersey cross 6 yrs.	104.6	86	28	Nil	18	6.0	3.86	10.8	39.04	121.26
2.	190	Jersey cross 3 yrs.	105.4	68	36		20	5.0	3.98	11.5	37.30	117.72
3.	201	Holstin Friesian Cross 4 yrs	104.8	66	34	Nil	24	6.5	4.18	4.45	40.29	89.28
4.	246	Jersey cross 3 yrs	105.0	74	38		24	7.0	4.68	4.6	33.21	86.53
5.	926	Jersey cross 8 yrs	107.0	84	30		22	5.5	4.24	4.8	40.14	81.52
	3151	Holstin Friesian cross 4 yrs	106.0	64	30		24	7.0	4.00	7.85	34.15	83.95
Mean			105.47	73.67	32.67	0.67	22	6.17	4.16	7.33	37.35	96.71
+S.E			+0.37	+3.84	+1.60	+0.21	+1.03	+0.33	+0.12	+1.31	+1.25	+7.29

Table 24: Clinical, haematological and biochemical mean values of healthy crossbred animals and pretreatment values of theileria affected crossbred cattle of group I and group II

Mean values parameter	Healthy control group	Before treatment with Buparvaquone (group I)	Before treatment with Oxytetracycline long acting + chloroquine phosphate (group II)
Temperature o _F	101.2±0.12 (15)	105.11±0.47** (7)	105.47±0.37** (6)
Pulse/min	57.73±1.15 (15)	75.57±4.72** (7)	73.67±3.84** (6)
Respiration/min	20.87±0.67 (15)	29.43±1.49** (7)	32.67±1.60** (6)
Rumen motility/2 min	2±0.14 (15)	0.43±0.20** (7)	0.67±0.21** (6)
PCV	30.38±1.01 (15)	19.71±0.84** (7)	22±1.03** (6)
Haemoglobin g%	10.71±0.32 (15)	5.93±0.32** (7)	6.17±0.33** (6)
Total erythrocyte count mill/cmm	5.26±0.24 (15)	3.92±0.13** (7)	4.16±0.12* (6)
Total leucocyte count (x10 ⁶ /cmm)	8.84±0.26 (15)	7.98±1.54 (7)	7.33±1.31 (6)
Blood glucose mg%	47.74±0.92 (15)	39.14±0.93** (7)	37.35±1.25** (6)
Serum iron ug%	150.83±6.98 (15)	85.88±9.95** (7)	96.71±7.29** (6)

Figures in parenthesis indicate number of animals

** Significant at 1% level

* Significant at 5% level

($P < 0.05$) total erythrocyte count in group I and group II respectively. The values are cited in table 24 and Figures 7 and 8.

4.3 CLINICAL TRIALS

4.3.1 Clinical trial with buparvaquone

The individual and mean \pm SE values of the all the parameters before commencement of treatment of 7 theileria affected animals were given in table 22.

While undertaking the therapeutic trials animals of group I were treated with buparvaquone @ 2.5 mg/kg body weight single intramuscular injection. On first day after treatment the mean temperature, pulse and respiration rates were recorded as 104.85°F , 74.28/min and 30/min respectively. Where as the general condition of the animals was not improved. The rumen motility was 0.571/2 min.

On third day of post treatment disappearance of bilateral nasal discharge was observed in case No.134. In other two cows (case No.74; 134) slight rumination was noted. But there was no improvement in the general condition of all the animals.

On fourth day of post treatment disappearance of cough in case No.235; rumination and appetite for good

Table 25: Clinical, haematological and biochemical observations in theileria affected crossbred cows, on the 12th, 20th day after treatment with Buparvaquone (Group - I)

Case No.	Breed	12th day after treatment										20th day after treatment									
		Temp °F	Pulse per min	Resp per min	Rumen moti. per 2 min	PCV %	Hb g%	Total eryth- rocyte count mill/cmm	Total Leuco- cyte count x10 ³ /cmm	Blood glu- cose mg %	Serum iron ug %	Temp °F	Pulse per min	Resp per min	Rumen moti. per 2 min	PCV %	Hb g%	Total eryth- rocyte count mill/cmm	Total leuco- cyte count x10 ³ /cmm	Blood glucose mg %	Serum iron ug %
26	HF Cross 5 years	100.8	58	18	2	26	7.5	4.52	7.15	39.76	81.52	101.0	56	20	2	28	8	5.62	7.0	41.53	89.29
74	HF Cross 6 years	101.6	59	24	1	20	5.0	3.86	4.4	39.13	117.75	101.4	58	24	2	22	6	5.29	6.55	43.84	178.57
134	Jersey Cross 5 years	101.0	56	22	2	22	5.5	3.98	5.65	41.30	117.75	100.8	60	24	2	22	6	4.91	8.25	43.84	128.96
235	HF Cross 3 years	101.2	62	20	2	18	6.0	3.96	5.4	41.15	114.43	101.2	58	20	2	20	8	5.08	8.6	42.32	121.34
678	Jersey cross 6 years																				died on 5th day of post treatment
4320	Jersey Cross 3 years																				died on 4th day of post treatment
6025	HF Cross 4 years	101.0	60	20	2	17	4.5	3.8	9.8	35.38	81.52	100.8	62	22	2	20	6	4.69	7.8	39.13	125.00
Mean		101.12	59	20.8	1.8	20.6	5.7	4.02	6.48	39.14	102.59	101.04	58.8	22	2	22.4	6.8	5.12	7.64	42.13	128.63
±		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
SE		0.14	1.0	1.02	0.2	1.6	0.51	0.13	0.93	1.07	8.62	0.12	1.02	0.89	0.00	1.47	0.49	0.16	0.38	0.87	14.33

Table 26: Clinical, haematological and biochemical mean values in theileria affected crossbred cows before and after treatment with Buparvaquone (group I).

Mean values parameter	Before treatment	After treatment with Buparvaquone			
		On 12th day		On 20th day	
Temperature °F	105.11±0.47 (7)	101.12±0.14** (5)	101.04±0.12** (5)		
Pulse/min	75.57±4.17 (7)	59.0±1.00* (5)	58.8±1.02* (5)		
Respiration/min	29.43±1.49 (7)	20.8±1.02** (5)	22±0.89** (5)		
Rumen motility/2 min	0.43±0.20 (7)	1.8±0.20** (5)	2±0.00** (5)		
PCV	19.71±0.84 (7)	20.6±1.60 (5)	22.4±1.47 (5)		
Haemoglobin g%	5.93±0.32 (7)	5.7±0.51 (5)	6.8±0.49 (5)		
Total erythrocyte count mill/cmm	3.92±0.13 (7)	4.02±0.13 (5)	5.12±0.16** (5)		
Total leucocyte count x 10 ³ /cmm	7.98±1.54 (7)	6.48±0.93 (5)	7.64±0.38 (5)		
Blood glucose mg%	39.14±0.93 (7)	39.14±1.07 (5)	42.13±0.87* (5)		
Serum iron ug%	85.88±9.95 (7)	102.59±8.62 (5)	128.63±14.33* (5)		

Figures in parenthesis indicate number of animals

** Significant at 1% level

* Significant at 5% level only

fodder was noted in case No.134. While clinical case No.4329 which was showing typical signs of theileriosis died.

On fifty day of post treatment case No.235 was bright in its general appearance and there was initiation of the previously suspended rumination.

On sixth day of post treatment case No.678 became very weak and recumbent with head drawn towards the flank with short spells of dry cough and died.

On the 12th day the mean temperature, pulse and respiration of the above survived 5 crossbred cows observed as $101.12 \pm 14^{\circ}\text{F}$, $59 \pm 1.0/\text{min}$. and $20.8 \pm 1.02/\text{min}$. respectively. There was a significant decrease in temperature, respiration rates ($P < 0.01$) and pulse ($P < 0.05$) after treatment. There was significant ($P < 0.01$) increase in rumen motility which became normal. The mean values are depicted in table 2:6.

After 20th day of post treatment the mean temperature, pulse and respiration of the above 5 crossbred cows observed as $101.04 \pm 0.12^{\circ}\text{F}$, $58.8 \pm 1.02/\text{min}$. and $22 \pm 0.89/\text{min}$. respectively. There was a significant decrease in the temperature, respiration ($P < 0.01$) and pulse ($P < 0.05$) after treatment. There was significant increase ($P < 0.01$) in rumen motility. The individual and mean values are presented in tables 25 and 26.

The mean values of PCV, haemoglobin, TEC, TLC, blood glucose and serum iron after 20th day post treatment were $22.4 \pm 1.47\%$, $6.8 \pm 0.49 \text{ g\%}$, $5.11 \pm 0.16 \text{ mill/cmm}$; $7.64 \pm 0.38 \times 10^3/\text{cmm}$; $41.57 \pm 0.88 \text{ mg\%}$ and $127.03 \pm 14.33 \text{ ug\%}$. There was a significant increase in ($P < 0.01$) total erythrocyte count ($P < 0.05$), blood glucose and serum iron when calculated by two sample 't' test against before treatment values. The mean values are presented in table 26 and Figures 7 and 8.

4.3.2 Clinical trial with oxytetracycline long acting (LA) and chloroquine phosphate

The mean values, individual values of the all the parameters in all cases before commencement of treatment were given in table 24.

While undertaking the therapeutic trial animals of group II were treated with Oxyvet LA (M/S Sarabhai Chemicals, Baroda) plus Lariago (M/S IFCA, Bombay). On first day after treatment the mean temperature, pulse, respiration rates and rumen motility were recorded as 105.23°F , 75/min. 33.33/min. and 0.166/2 min. respectively.

On third day post treatment the mean temperature, pulse, respiration rates and rumen motility were recorded as 104.9°F , 72.33/min, 33/min. and 0.33/2 min. respectively. There was reduction in the severity of enteritis in case No.201 and disappearance of cough in case No.246.

Table 27: Clinical, haematological and biochemical observations in theileria affected crossbred cows, on the 12th, 20th day after treatment with Oxytetracycline long acting plus chloroquine phosphate (Group - II)

Case No.	Breed	12th day after treatment										20th day after treatment									
		Temp o _F	Pulse per min	Resp per min	Rumen moti. per 2 min	PCV %	Hb g%	Total eryth- rocyte count mill/cmm	Total Leuco- cyte count x10 ³ /cmm	Blood glu- cose mg %	Serum iron ug %	Temp o _F	Pulse per min	Resp per min	Rumen moti. per 2 min	PCV %	Hb g%	Total eryth- rocyte count mill/cmm	Total leuco- cyte count x10 ³ /cmm	Blood glucose mg %	Serum iron ug %
116	Jersey cross 6 years	died on 6th day post treatment																			
190	Jersey cross 3 years	104.0	68	38	1	18	5.0	3.73	14.65	41.30	89.28	-----	died on 13th day post treatment								
201	HF cross 4 years	100.2	60	22	1	22	5.0	4.42	4.5	39.13	94.93	100.2	56	22	2	26	7.5	4.72	7.45	41.30	114.43
246	Jersey cross 4 years	101.6	58	20	2	22	6.0	4.81	5.4	39.13	117.75	101.8	58	24	2	28	6.5	4.97	8.35	41.53	125.00
926	Jersey cross 4 years	101.4	64	24	2	20	4.5	4.04	7.1	42.90	128.76	101.0	58	20	2	24	6.0	4.58	7.25	44.01	137.13
3156	HF cross 4 years	died on 4th day post treatment																			
Mean		101.8	62.5	26	1.5	20.5	5.12	4.25	7.91	40.61	107.68	101.0	57.33	22	2	26	6.67	4.76	7.68	42.28	125.52
±		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
SE		0.79	2.22	4.08	0.29	0.96	0.31	0.23	2.30	0.92	9.34	0.4	0.67	1.15	0.00	1.15	0.44	0.11	0.34	0.87	6.56

Table 28: Clinical, haematological and biochemical mean values in theileria affected crossbred cows before and after treatment with oxytetracyclin (LA) plus chloroquine phosphate (group II)

Mean values parameter	Before treatment	After treatment with oxytetracycline long acting plus chloroquine phosphate	
		on 12th day	on 20th day
Temperature o _F	105.47±0.37 (6)	101.8±0.79** (4)	101.0±0.46** (3)
Pulse/min	73.67±3.84 (6)	62.5±2.22 (4)	57.33±0.67* (3)
Respiration/min	32.67±1.60 (6)	26±4.08 (4)	22±1.15** (3)
Rumen motility/2 min	0.67±0.21 (6)	1.5±0.29 (4)	2±0.00** (3)
PCV	22±1.03 (6)	20.5±0.96 (4)	26±1.15** (3)
Haemoglobin g%	6.17±0.33 (6)	5.12±0.31 (4)	6.67±0.44** (3)
Total erythrocyte count mill/cmm	4.16±0.12 (6)	4.25±0.23 (4)	4.76±0.11* (3)
Total leucocyte count X 10 ³ /cmm	7.33±1.31 (6)	7.91±2.31 (4)	7.68±0.11 (3)
Blood glucose mg%	37.35±1.25 (6)	40.61±0.92** (4)	42.28±0.87** (3)
Serum iron ug%	96.71±7.29 (6)	107.68±9.34 (4)	125.52±6.56 (3)

Figures in parenthesis indicate number of animals

** Significant at 1% level

* Significant at 5% level only

Fig.7 MEAN HAEMOGLOBIN, TEC AND TLC LEVELS IN HEALTHY CONTROL, BEFORE AND AFTER TREATMENT IN GROUP I AND II

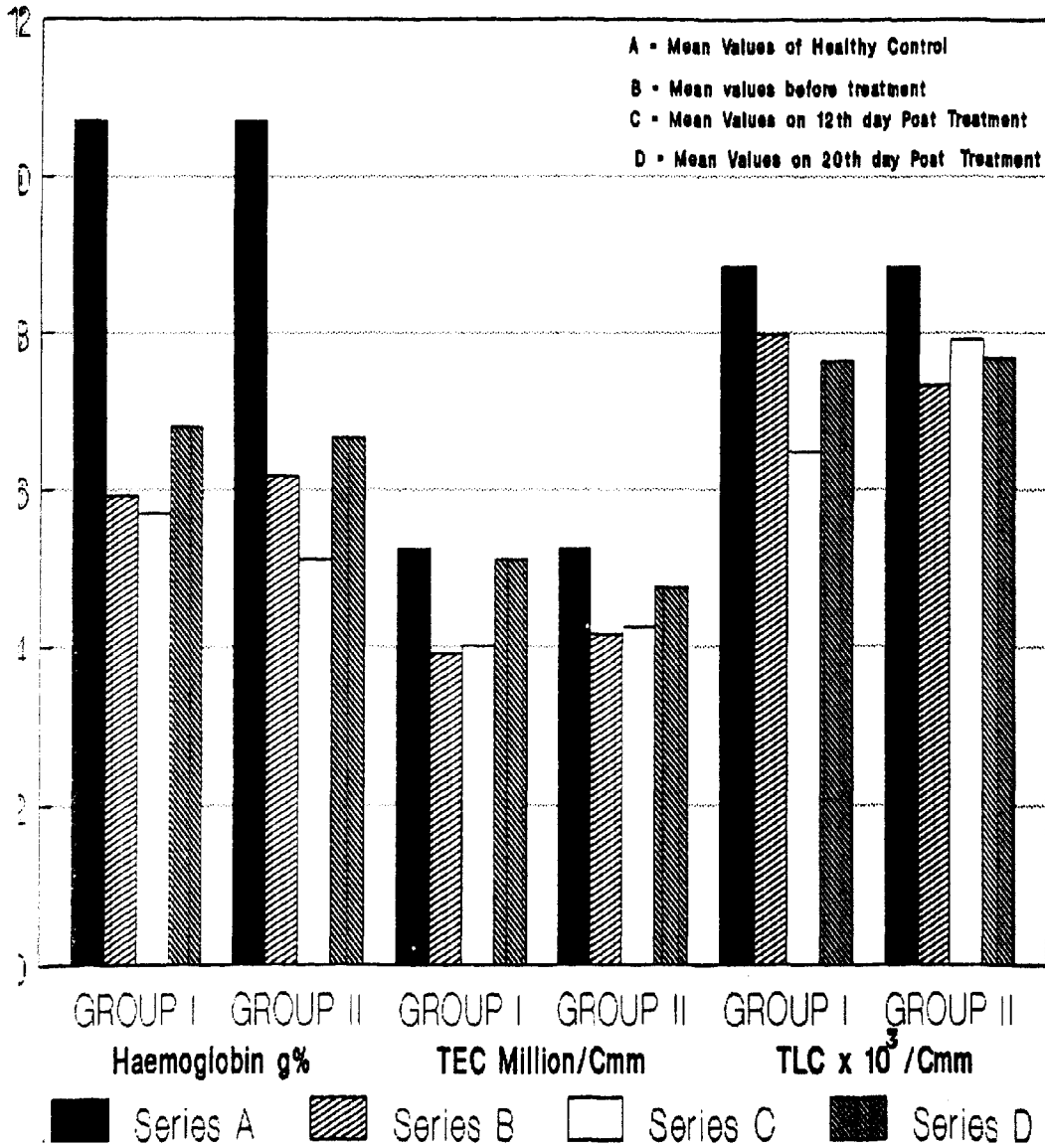
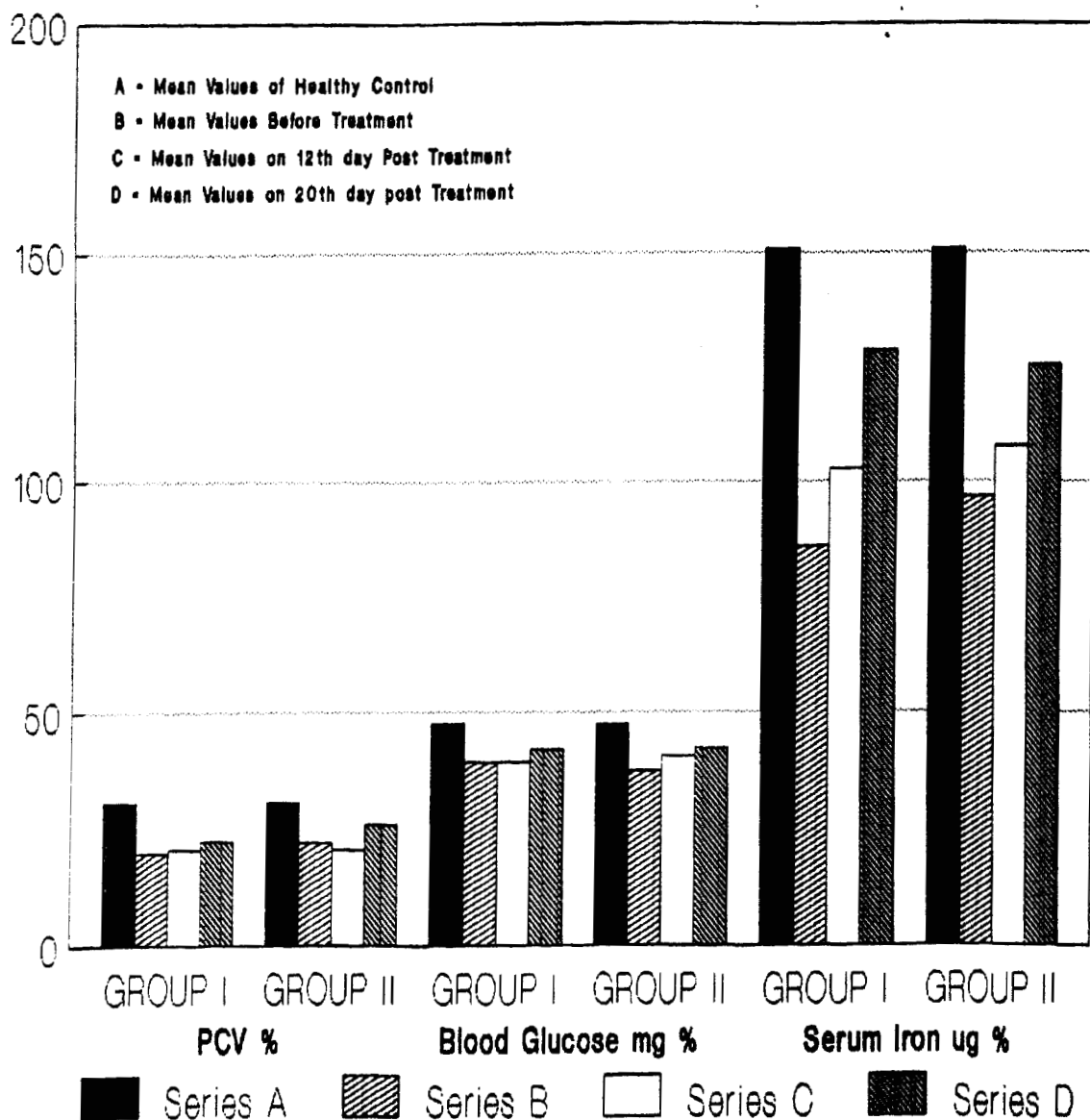


Fig.8 MEAN PCV, BLOOD GLUCOSE AND SERUM IRON LEVELS IN HEALTHY CONTROL, BEFORE AND AFTER TREATMENT IN GROUP I AND II



On fourth day of post treatment case No.3151 died with typical symptoms of theileriosis. Mean temperature, pulse, respiration and rumen motility of the remaining cows were recorded as 104.79^oF, 33.2/min, 32.4/min. and 0.8/2 min. respectively.

On sixth day there was initiation of rumination in case No.246 and disappearance of cough in case No.201. The mean temperature, pulse, respiration and rumen motility rates were recorded as 103.9^oF, 67/min, 30/min. and 1.25/2 min. respectively. Case No.116 died showing typical symptoms of theileriosis.

On seventh day case No.201 was bright and alert in appearance and was ruminating. The mean temperature, pulse, respiration and rumen motility rates of the surviving animals were recorded as 103.2^oF, 66/min. 28.5/min. and 1.5/2 min.

On eighth day of post treatment case No.246 was alert and started ruminating.

On 10th day the temperature, pulse, respiration rates of case No.926 became normal, the animal was bright, alert and was ruminating. There was slight improvement in milk yield.

On 11th day of post treatment in case No.190 relapses of the fever was observed. The animal became

weak emaciated, exhibiting symptoms of grinding of teeth, dry cough, bilateral mucous discharges from the nose.

On 12th day of post treatment except case No.190 all the survived animals were in good condition and were ruminating. There was also improvement in the general condition of the animals.

The mean values of temperature, pulse, respiration and rumen motility of the above 4 remaining crossbred cows were $101.8 \pm 0.79^{\circ}\text{F}$, $62.5 \pm 2.21/\text{min}$. $26 \pm 4.08/\text{min}$. and $1.25 \pm 0.28/2 \text{ min}$. respectively. There was significant decrease in ($P < 0.01$) temperature after 12th day post treatment. The individual and mean values are presented in table 27 and 28. There was significant increase in ($P < 0.01$) rumen motility.

On 13th day of post treatment case No.190 died with typical symptoms of theileriosis.

On 20th day of post treatment the mean temperature, pulse, respiration and rumen motility of the 3 surviving crossbred cows were $101.0 \pm 0.4^{\circ}\text{F}$, $57.33 \pm 0.66 \text{ min.}$, $22 \pm 1.15 \text{ min.}$ and $2 \pm 0.00/2 \text{ min.}$ respectively. There was significant decrease ($P < 0.01$) in temperature, and respiration rates and significant increase in rumen motility.

Table 29: Mean clinical, haematological and biochemical values after treatment with Buparvaquone (group I) and Lariago plus oxyvet LA (group II)

Parameter	After treatment with Buparvaquone		After treatment with oxyvet LA plus Lariago	
	On 12th day	On 20th day	On 12th day	On 20th day
Temperature °F	101.12±0.14 (5)**T	101.04±0.12 (5)**T	101.8±0.79 (4)**T	101.0±0.46 (3)**T
Pulse/min	59.00±1.00 (5)*T	58.8±1.02 (5)*T	62.5±2.22 (4)	57.33±0.67 (3)*T
Respiration/min	20.80±1.02 (5)**T	22.0±0.89 (5)**T	26 ±4.08 (4)	22.0 ±1.15 (3)**T
Rumen motility/2 min	1.8 ±0.20 (5)**T	2.0±0.00 (5)**T	1.5 ±0.29 (4)	2.0 ±0.00 (3)**T
PCV%	20.6 ±1.6 (5)**C	22.4±1.47 (5)**C	20.5±0.96 (4)**C	26.0 ±1.15 (3)
Haemoglobin g%	5.70±0.51 (5)**C	6.8±0.49 (5)**C	5.12±0.31 (4)**C	6.67±0.44 (3)**T,C
TEC mill/cmm	4.02±0.13 (5)*C	5.12±0.16 (5)**T	4.25±0.23 (4)	4.76±0.11 (3)*T
TLC X 10 ³ /cmm	6.48±0.94 (5)**C	7.64±0.38 (5)*C	7.91±2.31 (4)	7.68±0.34 (3)
Blood glucose mg%	39.14±1.07 (5)**C	42.13±0.87 (5)**C	40.61±0.92 (4)**T,C	42.28±0.87 (3)**C
Serum iron ug%	102.59±8.62 (5)**C	128.63±14.33 (5)**T	107.68±9.34 (4)*C	125.52±6.56 (3)**T

Figures in parenthesis indicate number of animals

**Significant at 1% level

*Significant at 5% level only

C as compared to values of control group

T as compared to before treatment values within the group

The mean values 12th, 20th days after treatment compared with before treatment values are presented in table 2g.

The mean PCV, haemoglobin, total erythrocyte count, total leucocyte count, blood glucose and serum iron after 20th day of treatment were $26 \pm 1.15\%$, 6.67 ± 0.44 g%, 4.76 ± 0.11 mill/cmm. $7.68 \pm 0.34 \times 10^3$ /cmm, 42.28 ± 0.87 mg% and 125.52 ± 6.56 ug% respectively. There was significant improvement in total erythrocyte count.

4.4 COMPARATIVE EFFICACY OF DIFFERENT DRUGS

In the buparvaquone treated group 5 out of the 7 theileria positive animals (71.4%) clinically recovered and observed alleviation of clinical symptoms like swelling of lymphnodes, pyrexia, cough observed within the period of 3-10 days of post treatment. Though two animals were free of parasitaemia on 1 day post treatment but it was only on day 7 onwards all the animals became negative for theileria in the stained blood smears.