Tick-borne diseases in cattle: Clinical and haematological findings, diagnosis, treatment, seasonal distribution, breed, sex and age factors and the transmitters of the diseases

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SUMMARY

Forty seven animals that had theileriosis (24 animals), anaplasmosis (13 animals), babesiosis (2 animals), theileriosis plus anaplasmosis (7 animals) and anaplasmosis plus babesiosis (1 animal) were the materials of the present study. Out of 47 animals, thirty one were exogenous or cross-breed and 16 were local animals. Again, 24 of them were cows, 11 bulls and 12 calves. Hypertrophy of lymphoid tissues, fever, anaemia, petechia, weight loss, nasal bleeding and abort were observed in the animals with theileriosis. Fever, anaemia, icterus, and haemoglobunuria were the most common clinical signs of the animals with babesiosis. Fever, anorexia and weakness were the only symptoms observed in the animals with anaplasmosis. Animals with theileriosis had significantly ($p>0.01$) lower PCV values. PCV values under 10 % were observed only in the animals with theileriosis. These animals also had significantly ($p>0.05$) lower rectal temperatures compared to the animals that had PCV values over 20 %. Infusion of colloids for treatment apart from antiparasiter drugs found to be life-saving in the animals which had PCV values under 10 %. Severity of the diseases were not significantly different when local and exogenous animals compared in terms of PCV and rectal temperatures. When PCV and rectal temperatures compared in terms of sex and age, calves found to be more resistant to the diseases than bulls and cows. Ticks could be collected from only 14 animals. These possible transmitters of the disease(s) were Rhiphicephalus (R) bursa, R. sanguineus, R. turanicus, Hyalomma (H) anatolicum anatolicum and H. anatolicum excavatum.

Key Words: *Theileriosis, babesiosis, anaplasmosis, cattle*

Sığırlarda kenelerden bulaşan hastalıklar: Klinik ve hematolojik bulgular, teşhis, tedavi, mevsimsel dağılım, tür, cinsiyet ve yaş faktörleri ve hastalığın taşıyıcıları

ÖZET

Bu çalışmanın materyalini 24'ü theileriosis'li, 13'ü anaplasmosis'li, 2'si babesiosis'li, 7'si theileriosis + anaplasmosis'li ve 1'i anaplasmosis + babesiosis'li olmak üzere toplam 47 hayvan oluşturdu. Bu hayvanlardan 31'i kültür ırkı veya melez, 16'sı ise yerli hayvanlardan oluşmaktaydı. Yine bu hayvanların 24'ü inek, 11'i tosun ve 12'si ise buzağıydı. Theileriosis'li hayvanlarda lenf yumrularının şişmesi, ateş, anemi, konjunktivalarda peteşi, kilo kaybı, burun kanaması ve yavru atma gözlendi. Babesia'lı hayvanlarda gözlenen en yaygın klinik belirtiler ise; ateş, kansızlık, sarılık ve kan işemeydi. Anaplasma'lı hayvanlarda ise sadece ateş, iştahsızlık ve halsizlik belirtileri görüldü. Theileria'lı hayvanlarda hematokrit değerin istatistiksel olarak önemli derecede diğer hayvanlara göre daha düşük olduğu gözlendi. Sadece theileria'lı hayvanlarda hematokrit değerin % 10'un altına düştüğü gözlendi. Hematokrit değeri % 10'un altında olan hayvanların rektal ısıları da, hematokrit değeri % 20'nin üzerinde olan hayvanlara kıyasla istatistiksel olarak önemli derecede düşük olduğu tespit edildi. Antiparaziter ilaçların dışında, kolloid sıvıların hematokrit değeri % 10'un altında olan hayvanlara verilmesinin hayati bir öneme sahip olduğu gözlemlendi. Hematokrit değer ve rektal ısılar yönünden kültür ırkı hayvanlar ile yerli hayvanlar karşılaştırıldığında önemli bir farklılık gözlenmedi. Bu değerler seks ve yaş yönünden karşılaştırıldığında, buzağıların inek ve tosunlara göre daha dirençli oldukları gözlendi. Hasta hayvanların sadece bazıları üzerinden toplanabilen kene türlerinin R. bursa, R. sanguineus, R. turanicus, H. anatolicum anatolicum ve H. anatolicum excavatum oldukları teşhis edildi.

Anahtar Kelimeler*: Theileriozis, babeziozis, anaplazmozis, sığır*

INTRODUCTION

Hemosporidian infections mainly theileriosis, babesiosis and anaplasmosis are serious and important tick-borne diseases of cattle throughout world. They are important constrains upon the improvement of livestock in the world and also in Turkey.

Theileriosis which is known as tropical theileriosis caused by *Theileria* (T) *annulata*, has been reported from every part of Turkey and is a major threat, particularly to exogenous and cross-breed cattle (29). It can cause 40-80 % mortality in enzootic areas (18). The vector of T. annulata are various species of *Hyalomma* (H). It is transmitted by three-host ticks such as *H. anatolicum anatolicum*, *H. anatolicum excavatum*, two host ticks such as *H. dentritum* and even by *H. scupense*, a one-host tick (2,5,16,22,33).

Bovine babesiosis is caused by the intra-erytrocytic protozoons mainly by *Babesia* (B) *bovis, B. bigemina B. major* and *B. divergens* in Turkey and represents a major problem for the livestock industry in tropical and subtropical areas of the world (1,5). Babesial infection causes fever, profound anaemia, haemoglobinuria and death may either occur within 24 hours or the disease last for three weeks (26). Important vectors of B. bigemina are *Boophylus* (Bo) *microplus* (12) and *Rhipicephalus* (R) *evertsi* (30). *Bo. microplus* is also vector of several other pathogens of cattle such as *B. bovis* and *Anaplasma* (A) *marginale* (25).

Anaplasma is very small parasite of the erythrocytes of ruminants. *A. marginale and A. centrale* are pathogens of cattle in the tropics and subtropics. *A. marginale* causes severe debility, anaemia, jaundice and abortion in adult cattle. On the other hand, *A. centrale* causes mild, inapparent disease (18). Anaplasma is transmitted biologically by ticks and

mechanically by blood sucking flies especially *tabanids*. *Dermacentor* (D) *occidentalis*, *D. andersoni* and *Bo. microplus* are the vectors of anaplasma (12,25,26,27). Transtidial transmission of *A. marginale* has also been demonstrated in *R. sangiuneus* ticks (23).

Although clinical signs, diagnosis, treatment and the transmitters of the diseases have been investigated well in the world and in Turkey, there isn't much report on clinical and haematological findings, different appearance of the culprit's in erythrocytes and lymphocytes (schizont form), transmitters, seasonal distribution, effect of breed, sex and age on the disease severity all together. Furthermore, detailed studies on this aspects have not also been done in the region of Van. In the present study, all these aspects of the diseases were aimed to investigate

MATERIAL AND METHOD

In the present study, forty-seven cattle aged between 1 month and 7 years old, which were brought to the Animal Hospital of the Faculty of Veterinary Science, University of Yüzüncü Yıl, were used as materials. After admission to the hospital, the animals were examined clinically. Body temperatures, condition of the mucoseas, lymph nodes and pocket cell volume (PCV) values (by microhaematocrit method) obtained at first. Breed, sex, age, respiration and pulsation rates were also recorded. When there was anaemia, petechia or icter on the mucoseas, high body temperature, swollen lymph nodes (for schizont form) or PCV values under 25 %, blood smears and smears from lymph nodes fluid were made. The smears were stained with Giemsa method and examined under microscope for the presence of either *Theileria* (T), *Babesia* (B) or *Anaplasma* (A). Ticks seen especially on the hairless areas of the animals were collected for the differentiation of tick species and for to evaluate the relationship between tick species and diseases possibly transmitted by them. Statistical analysis were made by Harvey pocket programme (11).

RESULTS

Clinical and haematological findings

The animals brought to the hospital for their unappitance, weakness, live weight loss, coughing, in some cases can't stand up, blood coming out from nose (in one case which was a month old calf), aborts (in one case which was 3-4 months pregnant) and reddish urine.

Weakness, live weight loss, anorexia, high body temperature, pethechia on the conjunctive mucosea, swollen lymph nodes, anaemia and coughing were the most common clinical symptoms seen in the animals with theileriosis. On the later stages of theileriosis; the animals couldn't stand up, their body temperatures were under normal values (T<38.5), ichterus, dehydration, blood in faeces were also occasionally seen clinical symptoms.

Weakness, live weight loss, anorexia, high body temperature, ichterus and haemoglobinuria were the most common clinical symptom seen in the animals, which had babesiosis. The most common clinical symptoms of anaplasmosis were anorexia, anemia and occasional high body temperature.

Severity of the diseases was evaluated according to clinical signs and PCV values. Some animal's condition considered being severe which had PCV value under 10%, low body temperature and general weakness. Animals with PCV values under 10 % most commonly had also significantly lower rectal temperatures (> 38.5 ^{o}C).

It can be seen from the Table 1 that animals with theileriosis had significantly ($p<0.01$) lower PCV values compared to the PCV values obtained from animals with anaplasmosis and theileriosis plus anaplasmosis. PCV values obtained from animals with anaplasmosis was also significantly higher ($p<0.05$) compared to the values obtained from the animals with theileriosis and the animals with theileriosis plus anaplasmosis ($p<0.05$).

Table 1: Comparison of PCV values (mean ± se) in the animals with different disease(s)

Disease(s)	PCV
T (n=24)	14.96 ± 1.27
A (n=13)	33.77 ± 2.79
B (n=2)	20.00 ± 4.00*
T+A (n=7)	22.29 ± 2.96
A+B (n=1)	13.00*

T= theileriosis, A= anaplasmosis, B= babesiosis, PCV= pecket cell volume, *=not statistically analysed

The animals was divided into three groups in terms of PCV values as PCV values under 10%, between 11 - 20% and over 20%. Rectal temperatures of these three groups are given in table 2. Statistical analyses were only performed to the values obtained from more than 4 animals. When rectal temperatures of the animals with theileriosis compared, it was found to be significantly higher ($p<0.05$) in the animals with PCV values higher than 20% compared to the animals that had PCV values under 10% and between 11-20%. Differences were also significant ($p<0.05$) when total rectal temperatures between groups compared as seen on the Table 2. PCV values under 10% were observed only in the animals with theileriosis. Animals with other disease(s) had no PCV values under 10%.

Differential diagnosis

Differential diagnosis was made on the basis of clinical, haematological findings and identification of the agents in the blood smears or in the smears obtained from lymph node fluid for schizont forms of *theileria* under microscope (31). *Theileria spp* were diagnosed microscopically from their blood smears as their ring, comma, parachute or batone forms (Picture 1ab,2ab). *Babesia spp* were diagnosed as their pear-shape (Picture 3b). *Anaplasma spp* were also diagnosed as their anaplasmoid forms (Picture 1b,2a). The species diagnosed according to literature (7) were *T. annulata*, *B. bigemina* and *A. marginale* and *A. centrale*.

Treatment

For the treatment of the theileriosis, buparvaquone were given. Diminazen aceturate and fenazon were given to the animals for the treatment of babesiosis. Oxytetracycline

were used alone for the treatment of anaplasmosis. Animals, which had dehydration and PCV values under 10 % also received fluid therapy (colloids) together with oxytetracycline, vitamin B_{12}, haemostatics and iron preparations. All animals treated got well except the cow that had abort and had 7 % PCV value. A bull with 7 % PCV and 36.4°C rectal temperature also died before starting treatment.

Tick species and diseases possibly transmitted by them

Tick species identified according to the literature (16). Ticks could be collected from only 14 animals. The reason for this is because the culprit may have been dropped from the animals after sucking blood. *Acaricid* drugs may have also been used before applying to the hospital. The tick species detected were *Rhipicephalus (R) bursa, R. sanguineus, R. turanicus, Hyalomma (H) anatolicum excavatum,* and *H. anatolicum anatolicum*.

Seasonal Distribution

The study was carried out between May 1998 and July 1999. Seasonal distribution of the diseases is given in Figure 1. It can be seen from the graph that the diseases generally seen in summer (June, July and August) which are the hottest months in a year in this region. Occasionally in spring (April and May) the diseases were also seen.

Effect of breed, sex and age on the diseases severity

Animals divided in two groups in terms of breed. They were exogenous (9 Holstein, 10 Swiss brown, 7 Simental, and 4 cross-breed) and local (16 DAK) animals. Mean PCV and temperatures of the animals in terms of breed is given in Table 3. It can be seen from the table that mean PCV and rectal temperatures were lower in the local animals with theileriosis compared to the same values obtained from exogenous animals. However, the values were not statistically significant. Mean PCV and rectal temperatures of the animals with anaplasmosis were in normal limits in both local and exogenous animals. Number of animals with babesiosis were very little in both local and exogenous animals. So, comparison was not made. In both breeds one animal for each had babesiosis and both PCV and rectal temperatures were under normal values. Only exogenous animals also had both theileriosis plus anaplasmosis (7 animals) and anaplasmosis plus babesiosis (1 animal). In both mix infections PCV values were lower than normal values.

The animals were divided into three groups in terms of age and sex. They were bulls (7 had theileriosis, 2 had anaplasmosis and 2 had theileriosis plus anaplasmosis), cows (15 had theileriosis, 4 anaplasmosis, 2 babesiosis, 2 theileriosis plus anaplasmosis and 1 babesiosis plus anaplasmosis) and calves (2 had theileriosis, 7 anaplasmosis and 3 had theileriosis plus anaplasmosis). Mean PCV and rectal temperatures of the animals in terms of sex and age are given in Table 4. PCV values were not significantly different when the values of bulls and cows with theileriosis compared. When total PCV values of bulls, cows and calves with either diseases were compared, the values of calves found to be significantly higher ($p<0.01$) than the values obtained from bulls and cows. When total rectal temperatures of bulls, cows and calves with either diseases were compared, the values were not significantly different. However, when rectal temperatures of bulls, cows and calves with theileriosis were compared, the values of calves found to be significantly higher ($p<0.05$) than the values obtained from bulls and cows.

Table 2: Comparison of rectal temperatures (mean ± se) of the animals in terms of different disease(s) and different PCV values.

Disease(s)	Temperature of the animals that had PCV values under 10%	Temperature of the animals that had PCV values between 11 and 20%	Temperature of the animals that had PCV values over 20%
T	38.39 ± 0.37 (n=8)	39.11 ± 0.39 (n=10)	40.20 ± 0.61 (n=6)
A	NP	39.50 ± 0.30 (n=2)	39.40 ± 0.26 (n=11)
B	NP	38.40 (n=1)	38.80 (n=1)
T+A	NP	40.00 ± 0.00 (n=3)	39.20 ± 0.60 (n=4)
A+B	NP	39.00 (n=1)	NP
Total (n=47)	38.39 ± 0.37 (n=8)	39.25 ± 0.24 (n=17)	39.56 ± 0.24 (n=22)

T= theileriosis, A= anaplasmosis, B= babesiosis, temp= rectal temperature, PCV= pocket cell volume, NP= not present

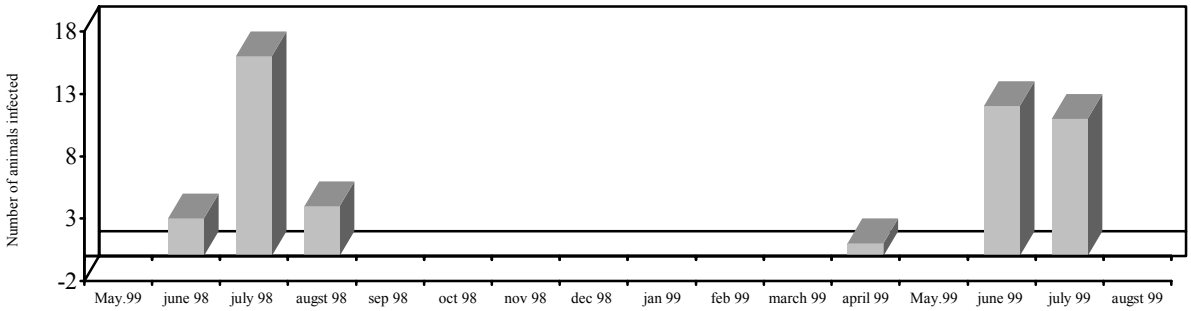

Figure 1: Seasonal distribution of the diseases

(a) (b)

Picture 1. (a) *Theileria annulata*; ring form (1), parachute form (2), comma form (3), *Anaplasma marginale* (4)

(a) (b)

Picture 2. (a) *Theileria annulata*; ring form (1), *Anaplasma centrale* (2), (b) *Theileria*; batone form (3) and ring form (4)

(a) (b)

Picture 3. (a) *Theileria*; schizont form from lymph node, (b) *Babesia bigemina.*

Table 3: Mean (±se) PCV and rectal temperatures (Temp) of the animals in terms of breed

Breed	Disease(s)		PCV	Temp ^{o}C
Exogenous (n=31)	T	(n=12)	16.00 ± 1.61	39.52 ± 0.35
	A	(n=10)	32.20 ± 3.41	39.45 ± 0.26
	B	(n=1)	24.00	38.80
	T+A	(n=7)	22.29 ± 2.96	39.54 ± 0.95
	A+B	(n=1)	13.00	39.00
	Total	(n=31)		
Local (n=16)	T	(n=12)	13.92 ± 1.99	38.77 ± 0.43
	A	(n=3)	39.00 ± 3.21	39.12 ± 0.19
	B	(n=1)	16.00	38.40
	Total	(n=16)		

T= theileriosis, A= anaplasmosis, B= babesiosis, Temp= rectal temperature, PCV= pocket cell volume

Table 4:Comparison of mean (±se) PCV and rectal temperatures (Temp) of the animals with different sex and age and with different disease (s).

Sex/age	Disease(s)	PCV %	Temp ^{o}C
Bulls (n=11)	T (n=7)	14.86 ± 3.03	39.11 ± 0.74
	A (n=2)	27.50 ± 0.50	39.20 ± 1.00
	T+A (n=2)	15.50 ± 3.50	40.00 ± 0.00
Cows (n=24)	T (n=15)	14.20 ± 1.42	38.85 ± 0.21
	A (n=4)	33.00 ± 2.65	39.30 ± 0.27
	B (n=2)	19.00 ± 5.00	38.60 ± 0.20
	T+A (n=2)	28.50 ± 3.50	39.35 ± 1.35
	A+B (n=1)	13.00	39.00
Calves (n=12)	T (n=2)	21.00 ± 0.00	41.40 ± 0.00
	A (n=7)	36.00 ± 4.92	39.49 ± 0.29
	T+A (n=3)	22.67 ± 4.98	39.37 ± 0.45

T= theileriosis, A= anaplasmosis, B= babesiosis, Temp= rectal temperature, PCV= pocket cell volume

DISCUSSIONS

Tick-borne diseases in cattle are the most common diseases in Turkey and are major treat to livestock (1,5,6,29,33). Clinical and haematological findings, diagnosis, treatment, transmitters, seasonal distribution, breed, sex and age factors in such important diseases needed to be examined.

For theileriosis; hypertrophy of lymphoid tissues, fever, pethecia, weight loss and haemolytic anemia have been reported by several workers (18, 26). Similar clinical findings also observed in the present study in the animals with theileriosis. Furthermore, in the present study a calf with theileriosis had also nasal bleeding. This could well be as a result of the culprit's direct effect on the permeability of peripheral vessels. Coagulation time in the animals with theileriosis has been reported to increase (10). That is possibly why petechia on mucosea occur in the animals with theileriosis. In such circumstances occasional bleeding may develop. Abort in a cow which had theileriosis and had low PCV (7%) and rectal temperature was also observed in the present study. Abort has been reported in the animals as complications of theileriosis (13). However, at early stages of pregnancy (3-4 months) this is the first report that theileriosis can cause abort.

It has been reported that infection with *Babesia* cause fever, profound anemia, ichter, haemoglobinuria (26). Although, only a few animals had babesiosis in the present study, clinical signs reported by Radostits et al. (26) were also observed in the present study. Because the number of animals with babesiosis in the present study was very little comparison of their clinical signs with other diseases was difficult.

A. centrale causes mild, inapparent disease. On the other hand, *A. marginale* causes severe debility, anemia, juandice and abortus in adult cattle (18). In the present study, animals with anaplasmosis had both *A. centrale* and *A. marginale* in almost all cases and apart from weakness, anorexia and fever other clinical signs reported by other workers for anaplasmosis was not observed.

Mix infections were also seen in the present study. Diagnosis of such cases is very important especially for the success of treatment. Similarly, mix infections have also been reported by other workers (6,9). Clinical signs in the animals with mix infections especially animals with theileriosis plus anaplasmosis somehow were less severe than the animals with theileriosis alone in the present study. Interestingly, PCV values in the animals with theileriosis plus anaplasmosis were also higher than in the animals with theileriosis alone (Table 2).

In the present study, differential diagnosis was made on the basis of clinical, haematological findings and microscopic appearances of the agents in the blood smears or in the smears obtained from lymph node fluid for schizont form of theileria. The species were diagnosed according to literature (7). For an accurate diagnosis of the culprits; species-specific serology should be applied which was not done in the present study. Therefore, future studies should include serology for the accuracy of differential diagnosis.

PCV is an accurate, practical evaluation of red blood cells status. PCV provides a simple, quick and accurate means of detecting anaemia (15). One of the most important feature of tick-borne diseases is anaemia. Rectal temperature is representative of the core body temperature. Fever is one of the most important clinical signs of tick borne diseases. Lowered rectal temperature is seen in moribund states. It is considered as poor prognostic sign in infectious diseases (8).

In the present study, the lowest mean PCV and rectal temperatures were observed in the animals with theileriosis. Eight animals with theileriosis had PCV values under 10 %. Again, rectal temperatures under normal values (38.5^{o}C) were seen mostly in the animals with theileriosis especially in the animals with low PCV values. Considering these results, it can be suggested that infection with theileriosis can cause much more severe disease and prognosis in such animals is poor as reported by Fraser et al. (8). *T. annulata* produces numerous schizonts and piroplasms and are very pathogenic. The pathogenicity of a *Theileria* species is related to the density of schizonts in lymphocytes and piroplasms in erythrocytes (18,31). Similarly, severely diseased animals had high density of schizonts in lymphocytes and piroplasms in the erythrocytes in the present study.

Drug administration is the main strategy for controlling haemosporidian infection although vaccines have played a very important role in the prevention of the diseases they cause (3). Effective drugs are diminazen, imidocarb and amicarbalide and the anti-theileria drugs, parvaquone and buparvaquone have proved promising in preliminary trials. The use of long-acting oxytetracyclines is a proven control of clinical disease with *Anaplasma* study (21,32). Results given in the present study in terms of treatment are parallel with above observations. In the present study, apart from antiparasiter treatment, fluid therapy especially using crystalloid solutions to the animals having PCV values under 10% was observed to be life-saving.

The diseases have been reported to cause high mortality rate among the exogenous breeds (5,19) and indigenous breeds reported to be relatively resistant (17,33). *T. annulata* has been reported from every part of Turkey and is a major threat, particularly to exogenous and cross-breed cattle (29). However, in the present study, clinical signs and prognosis of the disease was worst in the local animals than exogenous animals (Table 2). The reason surely is not because of exogenous animals are more resistant. One reason for this results could be that if the local animals are infected once, the immunity they own as a result of it may not be sufficient to protect them from further infections after a year. It has been reported that only repeated infection make the immunity permanent, but in the absence of further infection the beast becomes susceptible again after a year (26). The other reason could be that animal owners are less careful to their local animals health than their exogenous animals because exogenous animals are better in productivity and they pay more to get them. So, most probably, as soon as they saw any problem with their exogenous animals they applied to the hospital. Therefore, the disease(s) diagnosed at early stages in the exogenous animals, so, clinical signs were a bit better than local animals especially with theileriosis. Animal owners who has local breed usually try to treat themselves, if they can't then apply to veterinarians, by the time the severity of disease(s) gets worst.

It is well substantiated that pastured calves are less frequently ill with clinical babesiosis than adult cattle, a phenomenon often designed as inverse age resistant. Whereas, inoculation of *B. divergens* in newborn calves is taken a subclinical course which is uninfluenced by maternal antibodies (4). The existence of a non-immunological resistance factor has been demonstrated by Levy et al. (20), who by *in vitro* cultivation of *B. bovis* in blood from young calves, found a factor, other than antibody, responsible for the resistance of erythrocytes to growth of *Babesia* organisms (4). In enzootic areas, calves receive passive immunity from maternal antibodies in the colostrum which protect for about 11 weeks (26). The greatest infection rate is in animals 6 to 12 months of age and uncommon in animals more than 5 years old, but the severity of the disease increase with age (26). But, in the present study, calves with theileriosis had higher PCV and rectal temperatures compared to cows and bulls with theileriosis (Table 3). However, statistical analysis was not made because the number of calves with theileriosis were few. On the other hand, some other workers reported otherwise (18, 33). They reported that death occur mainly in calves (18) and that PCV values lower in the animals aged between 0-1 years old than the animals aged over 1 year old (33).

The vector of *T. annulata* are various species of *Hyalomma* (33). *T. annulata* is transmitted by three-host ticks such as *H. anatolicum anatolicum*, two-host ticks such *as H. dentritum* (22) and even by *H. scupense*, a one host tick (2). In the present study, *H. anatolicum anatolicum* and *H. anatolicum excavatum, R. turanicus, R. sanguineus* and *R. bursa* were collected from infected animals. According to Barnett (2), *H. anatolicum excavatum* can not be a vector in the field although it is readily infected experimentally. On the other hand, some other workers describe *H. anatolicum excavatum* as three-host tick and a vector of *T. annulata* (16,28). It has also been reported that the tick of the genus *Rhiphicephalus* may also transmit different *Theileria spp* (22). Some workers have shown that *Rhipicephalus* tick species can transmit all *anaplasma* (23), *babesia* (30) and *theileria* (14,22). Important vector of *B. bigemina* is *Bo. microplus* (12). However, in the present study*, Bo. microplus* species were not seen on the animals infected with babesiosis.

It has been reported that both the number of ticks and the number of animals with ticks high in June-October period (33). *T. annulata* seen most commonly in August and *B. bigemina* in September (1). Clinical infections caused by *T. annulata* were seen between April and December being most commonly in June and July (5,6,24). Similarly, in the present study, first infection appeared in April. Monthly prevalence of infection increased in June and continued in July (Figure 1). This seasonal distribution is very much related to weather conditions. In this region, the hottest months are between May and August. Because, the ticks are more active in these months. Similar findings were reported by other workers in different parts of Turkey (29).

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