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Tick and tick borne diseases in Khartoum state

القراد و الامراض المنقولة عن طريق القراد في ولاية الخرطوم

Dissertation Submitted in Partial Fulfillment of Requirement for Degree of Honor Bachelors of Veterinary Medicine and Animal Surgery.

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Dedication:

This work is dedicated to:

Themostprecious people in our life, our perseverant, hard workingparent, who never stopped giving our guidance and inspiration.

Acknowledgment

We would like to thank Allah who gave us the aptitude and patience to conduct this work.

Our thank is extended to our supervisor Dr. Sara Bashier for help and advice throughout this work, then with great respect we would like to express our great thanks and gratefulness and appreciation to Prof. GalalAldinElazhari .

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Abstract

This study was aimed to investigate the prevalence of tick and tick -borne diseases (*Theileria*, *Babesia*, and *Anaplasma*) in Khartoum state. The procedure used was collection of data from different areas and localities, namely Khartoum, Omdurman and Bhari. Data were analyzed with appropriate statistical methods. The results indicated that the high incidence of tick and blood parasite was highest in Khartoum locality, followed by Omdurman and the least incidence was in Bahri. In Khartoum the incidence of tick and blood parasite was high in bovine, in Omdurman the incidence was high in equine, in Bahri the incidence was high in bovine also .*Babesia*was of high incidence in Khartoum followed by Omdurman and then Bhari.*Anaplasma*was of similar occurrence in Khartoum and Omdurman .And absent in Bhari. Tick were of high incidence in Khartoum Omdurman and Bhari. The incidence of blood parasites during(2016-2017) was recorded according to the month of year. The incidence of blood parasites according to species showed that *Babesia* was high in equine, *Theileria* was high in bovine and *Anplasma* was high in equine. Tick infestation was high in canine. Mixed infection was mainly recorded in bovine, ovine and caprine .Statistical analysis revealed that there is significant effect of state, locality, year, month, age and species on the occurrence of blood parasite. It could be concluded that blood parasite and tick are prevalent in Khartoum state and control and preventive measures should be applied.

Key words:

Prevalence, Record, statistical analysis, *Babesia* ,*Theilera,Anaplasma* .

مستخلص الأطروحة

هذه الدراسة هدفت الى تقصى مدى انتشار القراد والامراض التى ينقلها القراد . متمثلة فى الثايليريا والبابيزيا والاانابلازما فى ولاية الخرطوم.طريقة الدراسة تمت من خلال تجميع المعلومات من محليات ولاية الخرطوم وهى الخرطوم امدرمان وبحرى.تم تحليل المعلومات عن طريق التحليل الاحصائى المناسب.النتائج دلت على أن حدوث طفيليات الدم والقراد كانت الأعلى فى محلية الخرطوم وبعدها امدرمان والأقل كانت فى بحرى.نسبة الحدوث لطفيليات الدم والقراد كانت الاعلى فى الابقار فى محلية الخرطوم,وفى امدرمان نسبة الحدوث كانت الاعلى فى الخيول, وفى بحرى كانت نسبة الحدوث الاعلى فى الابقار.طفيلى البابيزيا كان الاكثر حدوثا فى الخرطوم وبعدها امدرمان والاقل فى بحرى.طفيلى الانابلازما كان حدوثه متساويا فى الخرطوم وامدرمان ولم تسجل نسبة حدوث فى بحرى. القراد سجل بنسبة عالية في الخرطوم وامدرمان وبحرى.ايضا نسبة حدوث طفيليات الدم فى السنوات 2016 - 2017وشهورها.تم تسجيل نسبة الحدوث مقرنة بنوع الحيوان,وقد كان طفيلى البابيزيا الأكثر فى الخيول وطفيلى الثايليريا الأكثر فى الابقار والانابلازما كانت الأكثر في الخيول.القراد كان الاكثر في فصيلة الكلاب.تواجد أكثر من طفيلى واحد فى الحيوانات تم تسجيله بصفة رئيسية فى الأبقار والضأن والماعز.الإحصاء الحيوى أثبت أن هنالك تأثير معنوى بين حدوث طفيليات الدم والقراد والولاية والسنة.الدراسة خلصت الى أن طفيليات الدم تحت الدراسة والقراد تعتبر منتشرة فى ولاية الخرطوم تستوجب القيام باجراءات السيطرة ومنع الحدوث.

كلمات المفتاح :

تفشِ , سجلات , التحليل الإحصائي , بابيزيا , ثايليريا , انابلازما .

Introduction

The medical and economic important of ticks has long been recognized due to transmit disease to human and animals. Ticks cause great economic losses to live stocks and adversely effect in livestock hosts in several ways loss blood is direct effect of tick acting as potentially vector for haemo-protozoa and helminth(tick)Parasitic disease is global problem and considered as major obstacle in the health and product performance of animals. These may be due to endo-parasites that live inside the body, or ecto-parasite such as tick, mites flies, fleas, midges, etc., which attack the body surface. Among ecto-parasite, ticks are very important and harmful blood sucking external parasites of mammals, birds and reptiles throughout the world (Furman and Loomis, 1984).

tickblong to phylum, arthropod, and make up the largest collection of acarine.Tick -borne protozoan diseases (e.g.Theilerosis and Babesiosis) and rickttsial disease (e.g.Anaplasmosis) and Cowdriosis and tick associated dermatophilosis are major health and management problems of livestock in ma developing countries. The economically most important iodide ticks of livestock in tropical region belong to generate Hyalomma, Boophilus, Rhipicephalus, and Amblyomma) (Frans, 2000).

Ticks affect domestic animals directly with non-specific symptoms such as anaemia, restlessness, dermatosis, toxicosis, paralysis, loss of condition and decrease in milk production(Jonsson, 2006).

Tick control is a global problem and is therefore a priority for many countries (Lodos*and Boue*, 2000).

Control of tick infestations rests overwhelmingly on the use of conventional acaricides, although the disadvantages are recognised. A broad range of acaricidesincluding arsenical chlorinated hydrocarbons, organophosphates, carbamates, formamidines and synthetic pyrethroids – is being used to control ticks on livestock (Rajput *et al.*, 2006).

Objectives

1. To determine the prevalence of tick borne diseases in Khartoum State.

2. To determine the level of incidence of the diseases (babesiosis, theileriosis ,anaplasmosis , heart water and tick infection) in Khartoum State.
3. To identify species of animals infected with tick and tick- borne diseases in Khartoum State.

Chapter One

Chapter one
Literature review

1.1 GENERAL INFORMATION ABOUT TICKS.

Ticks are the most important ectoparasites of livestock in tropical and subtropical areas and are responsible for severe economic losses both through the direct effects of blood sucking and indirectly as vectors of pathogens and toxins. Feeding by large numbers of ticks causes reduction in live weight gain and anemia among domestic animals while ticks bites also reduce the quality of hides. However, the major losses caused by ticks are due to the ability to transmit protozoan, rickettsia and viral diseases of which are of great economic importance worldwide (Jogenjan and Uilenber, 1994).

Ticks are ectoparasites of livestock, which are classified (together with mites) in the order*Acari.* All ticks are obligate ectoparasites of vertebrates. They have four pairs of legs as nymphs and adults and the body is divided into the capitulum (which bears the mouth parts) and the opisthosoma. There are at least 840 tick species in two major families namely the *Ixodidae* or hard ticks (so called by virtue of their hard dorsal shield) and the *Argasidae*or soft ticks (due to their flexible leathery cuticle). The family *Ixodidae* comprises approximately 80% of all tick species, including the species of greatest economic importance. However, *Argasidae*ticks also play a significant role as vector of diseases specially in poultry.Hard tick distinguished by a dorsal shield, small in female, but covers the entire dorsal surface in male. They are also tapered interiorly and the mouth Parts are readily visible from the dorsal view. Soft ticks are leathery and without a dorsalshield. Their mouth parts are subterminally attached and not visible from the dorsal view (Jongejan and Uilenberg, 1994).

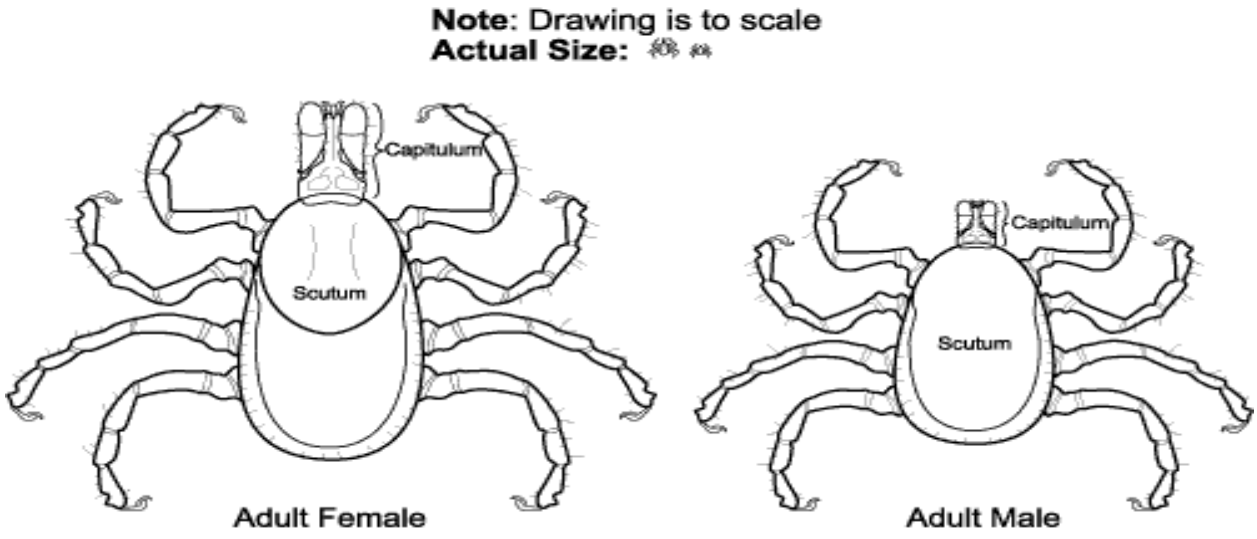

Fig (1) ***Ixodesscapularis*** **(Black – legged tick)**

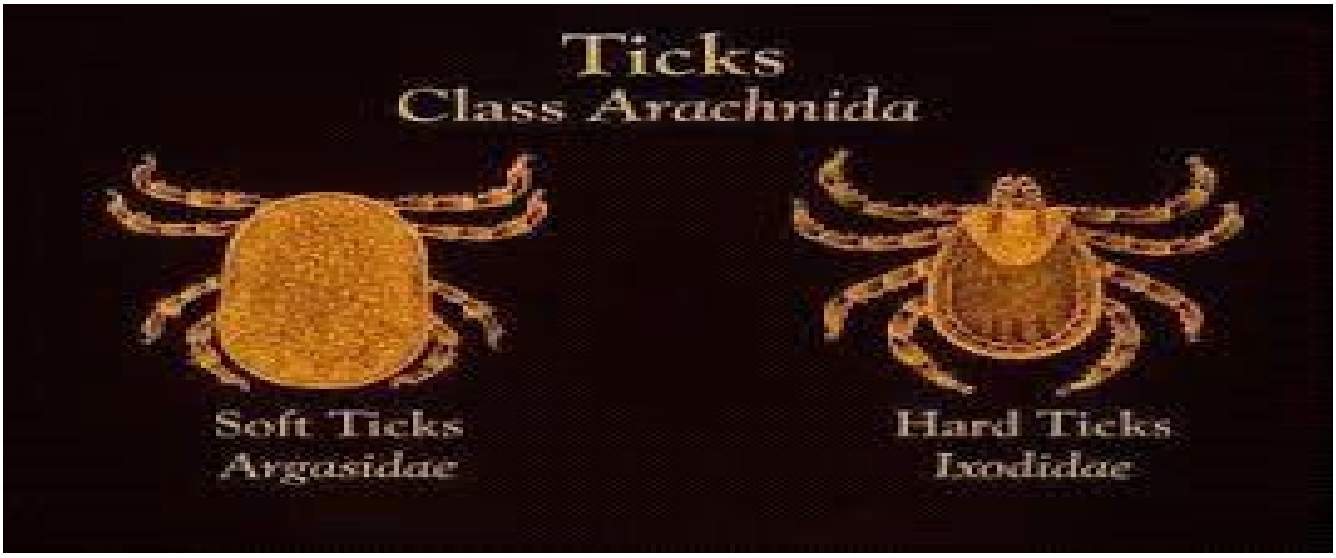

Fig (2) Ticks class*Arachnida*

1.2 THE MAIN GENERA OF IXODIDAE TICKS

1.2.1 *BOOPHILUS*: The genus *Boophilus*contains only five species of small ticks, all of which are one host ticks and take approximately three weeks to complete their blood meal preferably on cattle (except for *B. Kohlsi*, a Near /Middle eastern species with a prediction for small ruminants). *Boophilus* species have short palps which are ridged dorsally and laterally and they possess

eyes which sometimes difficult to discern. *Boophilus* ticks have short mouthparts which are unable to penetrate very deeply into the skin. However, damage to hides is considerable as the preferred feeding sites are often ofgood leather potential. *B. Microplus* is the most importantspecies (Jonegjan and Uilenberg, 1994).

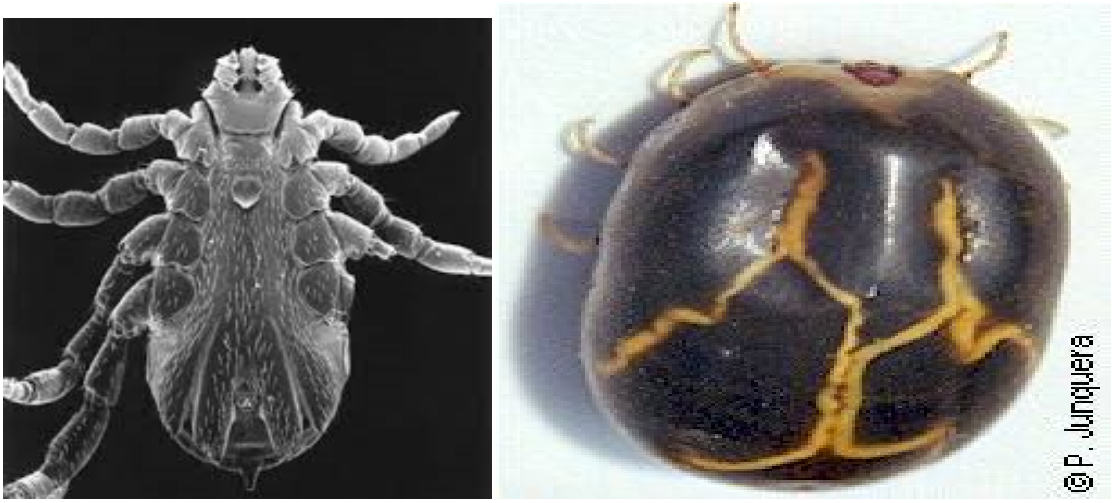

Fig (3) ***Boophilus***

1.2.2 ***DERMACENTOR****:* The genus *Dermacentor* comprises approximately 30 species. TheseTicks have ornate scotia, short palps, eyes and usually follow a three host – cycle (exceptions include the American*D.pictus*) so called winter tick) and *D.nitens* which are both one host ticks). *Dermacentorspp.*Occur on all continents expect Australia. In Eurasia several species (e.g*D. Marginatus* and *D. Reticulatus*) infest livestock and other domestic animals. In North America D.*Variabilis* and D.*Undersoni* are also important ectoparasites of livestock. *Dermacentor* or (*Anocentor*) *nitens*, the tropical horse tick , is present in an area which extends from the southern USA through to central and south America. *D.nitens* is aone hosttick, originally found on deer in South America and has a predilection for their host. In Africa, Dermacentortick don't play a significant role for livestock (Jongejan and Uilenberg, 1994).

Fig(4) Dermacentor

1.2.3 *HAEMAPHYSALIS*: The genus *Haemaphysalis* contains approximately 155 species. They are easy to differentiate from other genera by characteristic lateral projection of Palpal article 2 beyond the margins of the basis capituli. All Haemaphysalis*Spp.*are eyeless, three host tick. Only a few species have adapted to domasticlive stock. For example *H.bispinosa* occurs on cattle on the Indian subcontinent. *H.longicornis* is an East Asian species occurring on cattle and other domestic animals and has been introduced into Australia, New Zealand and New Caledonia. In Australia *H.longicornismaintains* itself by parthenogenesis (reproducing without males) , whereas normal bisexual populations of the same tick exist in eastern Asia side by side with parthenogenesis populations , the reason for this difference is unknown. In Europe, *H.punctata* is common on ruminants (Jongejan and Uilenberg, 1994).

Fig (5*)* *Haemaphysalis*

1.2.4 ***HYALOMMA***: *HyalommaSpp* are median to large sized ticks with long palps and eyes typically in sockets. *Hyalomma Spp*. Parasitesdomestic and wild animals and bird and are abundant in semi-arid ' zones. The genus *Hyalomma*comprises approximately 30 species, most of which follow a three host life cycle. However, some species undergo either a two host or a three host cycle, depending on the host species. Adult *Hyalomma*ticks actively run out from their testing sites when a host approaches, unlike most other *ixodidae*ticks which wait on vegetation. One species *H.Scupense* usually hase a one host cycle and occurs on cattle in southern Europe and south western Russia. As an exception to the situation for other tickspecies, this tick may overwinter on the host(Jongejan and Uilenberg, 1994).

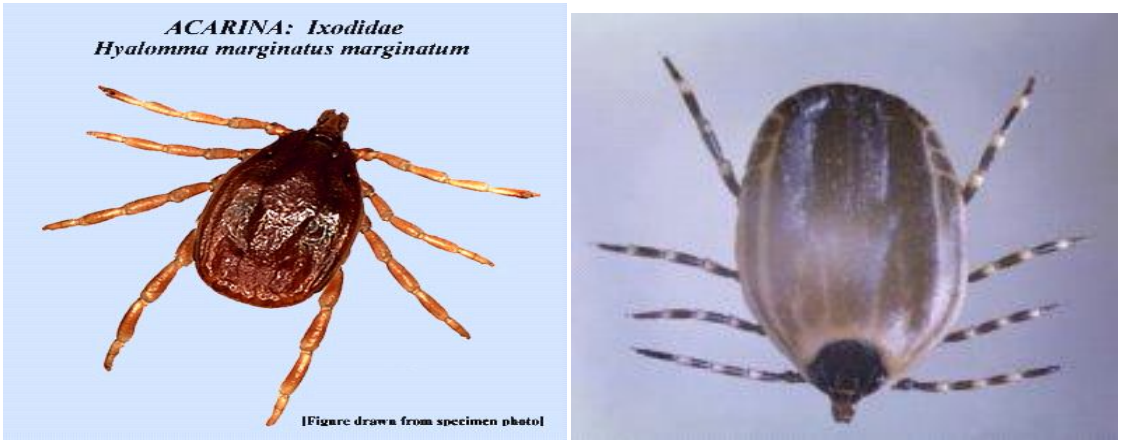

Fig (6) *Hyalomma*

1.2.5 ***IXODE*:**species form the largest genus of hard ticks and belong to aseparate branchof the*Ixodidae,theProstriata*. The 250 species belonging to genus *Ixodes*are characterised by anal groove curringanteriorly to the anus this easily differentiates Ixodidaefrom theother genera of hard ticks metastriata , in which this groove curves posteriorly around the anus. The scutum of Ixodesspp lacks ornamentationand there are no eyes. (Jongejan and Uilenberg, 1994).

Fig(7a) ***Ixodes***

1.2.6 ***RHIPICEPHALUS***: Thegenus*Rhipicephalus*comprises approximately 70 species. These are small to medium sized tickswith short broad palps, most species are in ornate. When viewed from the dorsal aspect the basis capituli has adistinict hexagonal shape with protruding lateral margins. Males has ventral plates near the anus. Both sexes have eyesand festoons. Most Rhipicephalus*spp* arefound on mammals on the African continent. These areusually three host ticks. Although some have twohosts – cycle (Jongejan and Uilenberg, 1994).

Fig(7b)*Rhipicephalus*

1.2.7 ***AMBLYOMMA****:*The genus *Amblyomma* comprises over 100 species characterized by long mouthparts and usuallybeautifully colored, ornamented scuta. The eyes are usually not housed in sockets. These three – host ticks are wide spread in tropical and subtropical zones, where they parasites a wide variety of mammalian hosts , and also reptiles and amphibians. The immature stages of some species infest birds, which can play an important role in dispersing the ticks (Jongejan and Uilenberg, 1994).


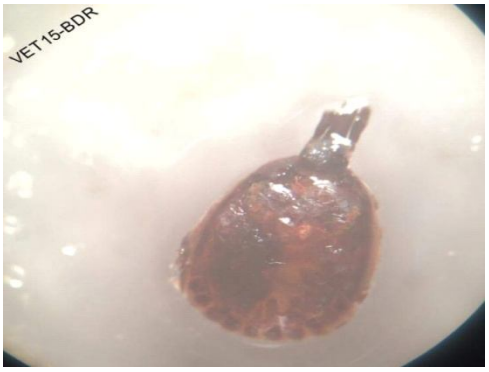

Fig (8*) Amblyomma*

Table (1) Some bacterial disease transmitted by ticks.

The genera of tick	The disease can transmit
Boophilus	Babesiosis
Dermacentor	Tularemia,Q fever, spotted fever disease.
Haemaphysalis	Q fever
Hyalomma	Rickettsiasis, theileriosis, Crimean Congo haemorrhage fever virus.
Ixodes	Anaplasmosis, Lyme disease.
Rhipicephalus	Human monocytogenicehrlichiosis, Q fever, Mediterranean spotted fever.
Amblyomma	Tick borne African fever, Q fever, Rocky mountain spotted fever disease, ehrlichiosis.

Table (2) Some viral disease transmitted by ticks.

The genera of tick	The disease can transmit
Ixodes	Powassanencephalitis, Tick borne encephalitis, Tyuleniy virus, Lagat virus, Omsk haemorrhagic fever.
Dermacetor	Powassaencephalitis, Colorado tick fever, Omsk haemorrhagic fever.

Haemaphysalis	Powassan encephalitis, Kyasanur forest disease, Syndrome with severe fever.
Hyalomma	Crimean-congohaemorrhagic fever.

1.3 TICK ECOLOGY:

1.3.1 Habitats: A tick's is composed of variety o f living and nonliving things in the space in which it lives. Ticks are adapted to two contrasting componentsoftheir habitat; The physical environment. And their host.When ticks are moulting and when questing in the physical Habitat they are in danger of drying out and starving. The larvae are most susceptible because of they have a high surface area relative to their small volume. They are also exposed to predators such as rodents,birds,reptiles and ants, and to pathogens such as fungi. These adverse factors limit the type of Habitats that a species will be found in and knowledge of the typical physical Habitat of a species is an aid in identification. The most important component of physical habitat of a tick is the climate that is defined by temperature and humidity. When the same tick is on the host it is nolonger of danger of drying out or starving, but is in danger of beingremoved by the host's grooming or having it's feeding reduced by host immunity. Most ticks have adaptations in their behavior and physiology of feeding to reducethese host reactions. Usually these adaptations worksbest fora certaintype of host. However, the distribution of thepotential hosts of a species of tick may often be much longer than the distribution of the tick. Ticks feeding ontheir hosts may also be eaten by domestic chickens and oxpeckerbirds (Latif andWalker, 2004).

1.3.2 HOSTS: Most ticks have characteristic species of hosts to which they are adapted this host may be a single species but more commonly are a group of similar species. For example, all the *Boophilus*species are highly adapted to feed on cattle but some*Boophilus*may survive by feeding on sheep. Because *Boophilus* are one - host ticks all stages must be able to feed properly on the same species of host. Compare this with *Rhipicephalusappendiculatus*that is found most commonly on cattle. All stages feed well on cattle and similar hosts in the family Bovidae such as sheep and goats and many wild species such as Buffalo and eland. They are also found attached to a very wide range of hosts in other families from primates, including humans, dog's, zebra lion's and hares. The survival of a population of ticks depends on the presence of hosts suitable for reproduction by theadults. These hosts are known as maintenance hosts. These hosts are more limited in variety than the hosts on which larva and nymphs of three host ticks can survive. They are also more

limited than those on which adults may attempt to feed but not necessarily survive. To use information of tick hosts for identification it is important to realize that a species of tick has a characteristic range of host species but maybe found much less commonly on many other kinds of host species. For example, carnivorous, mammals maybe infested temporarily with ticks which have transferred from their herbivorous prey (Latif and Walker,2004).

1.3.3Seasonal Occurrence: The activity of many species of tick is adapted to seasonal variations in climate. In the tropics this is usually the to overcome the adverse effects of a long dry season. The survival of many species is improve if they have a seasonal cycle which reduces this risks. For *Rhipicephalusappendiculatus* in southern Africa has mechanisms known as diapauses that delay questing of adults so that their feeding and reproduction starts at the beginning of the single rainy Season. This is followed by Peak numbers of larvae towards the end of the rainy Season when humidity is highest. Knowledge of the time of year when adults of a species are likely to be found on their hosts is thus an aid to identification (Latif and Walker,2004).

1.3.4 Geographical Distribution of ticks:

For some species of ticks there are many published records of the geographical sites in which they have been found. These records can be converted into maps which give a general distribution of where a species is likely to be found because of where it has been found before. If a species has only ever been recorded north of the Sahara when it is unlikely to be found to the south.However, this important aid in identification has several complications. For example, the type of habitat in which the species is found is likely to be much more widely distributed than the current geographical range of the tick. Thus a tick found in a similar habitat but a fare away geographical area from usual distribution could have become imported recently. Also these maps depend on data from tick surveys which vary in their extent from country to country so gaps in distribution on a map may mean that nobody has looked for them there (Latif and Walker,2004).

1.4 The Diseases :

1.4.1 Babesiosis:

1.4.2 Etiology:

*Babesia*is a protozoan parasite found to infect vertebrate animals, mostly livestock mammals and birds, but also humans. Common names of the disease, which *Babesia*microticauses are Texas cattle fever, redwater fever, tick fever, and Nantucket fever. (Ristic*et al.*,1984) .

B. bovis and *Babesiabigemina* prefer to infect cattle in tropical environments, they can infect other animals, such as the white-tailed deer. (Chauvin*et al.*,2009).

1.4.3Life cycle:

Babesia is transmitted by ticks of the family *Ixodidae* between these hosts. To begin, the tick as the definitive host become infected themselves as it takes up gametocytes when attached for a blood meal. It also introduces the *Babesia* into the intermediate host (cattle e.g.) when taking a blood meal. As *Babesia*enters the animal´s red blood cells (erythrocytes) they are called sporozoites. Within the redblood cell, the protozoa become cyclical and develop into a trophozoite ring. The trophozoitesmoult into merozoites, which have a tetrad structure coined a Maltese-cross form (Herwaldt*et al.*,2003).

1.4.4 Transmission:

Babesia species are spread through the saliva of a tick when it bites. Already at its

nymphal stage, a tick bites into the skin for a blood meal. The tick, if not removed, stays attached for three to four days, some species of *Babesia*can be transmitted from a female tick to its offspring before migrating to salivary glands for feeding (Despommier,1995).

1.4.5 Clinical signs:

Affect animals suffered from fever, loss of appetite cessation of rumination,Labored breathing, emaciation,progressivehemolytic anemia, various degree of jaundice,Hemoglobinuria, accelerated heart and respiratory rates, ocular problems, drop in milk production(El moghazy*et al.*,2014).

1.4.6 Diagnostic tests:

As a protozoan parasite, the most effective way to identify *Babesia* infection is through blood sample testing. *Babesia* species enter red blood cells(erythrocytes) at the sporozoitestage. Morphology Within the red blood cell, the protozoa become cyclical and develop into a trophozoite ring. The trophozoitesmoult intomerozoites, which have a tetrad structure coined a Maltese-cross form (Herwaldt*et al.*,2003).

Prevention in animals in 1906, efforts were made to eradicate the tick vector of bovine babesiosis in the United States. This eradication was recorded as being successfully completed four decades later (Ristic*et al.*,1984).

Effective control can be achieved by vaccination with live attenuated phenotypes of the parasite. The vaccines have a number of drawbacks, so better, a safer vaccines are still being researched (Ristic*et al.*,1984).

1.4.7 Treatment:

Control of bovine babesiosis, anti- babesiosis drugs, or by combination of this approaches (Suarez and Noh 2011), chemotherapy of babesiosis is important for controlling the disease either to treat field cases or to control artificially induced infection (Rodriguez and Trees,1996).

1.5 Anaplasma:

1.5.1 Etiology:

Anaplasmosis is caused by *Anaplasmamarinale* in the United States. It is a gram negative bacteria and is considered to be an obligate intracellular organism. There are two forms; one form is intracellular and the other form survives outside the red blood cell. It makes sense that is has an extracellular form in order for it to infect other red blood cells or actually pass through the placenta to the fetuses.All the strains we have identified, which probably is an incomplete list, are infective in cattle. Some of those strains, however, are not able to infect ticks. In areas where those strains are endemic, other modes of infection are more important than the ticks. Generally though, ticks are very important vectors for this disease (https://www.drovers.com/contributor/gregg-hanzlicek-dvm-phd-director-production-animal-field-disease-investigations-kansas).

Bovine anaplasmosis, caused by *Anaplasmamarginale*, is an infectious but non-contagious disease (Aubry and Geale, 2011).

1.5.2 Transmission :

There are three modes of transmission for the *Anaplasma*pathogen: biological, mechanical, and transplacental. For biological transmission, the primary vectors are ticks, which serve as amplifiers. When ticks feed on a positive animal, the bacteria establish inside the tick reproduce, primarily in the hind gut and the salivary glands, and the concentration can reach very high levels. When the tick feeds on an animal it will pass those bacteria through the saliva. The second mode of transmission is mechanical, mostly involving horse, stable, and deer flies. Horn flies are not thought to be a major mover of this disease amongst populations. Flies don’t amplify the organism like the ticks do, so the bacteria those flies pick up when feeding is the maximum they will be able to pass on to

the next animal when they take their blood meal. They do pass it, but they don't amplify it. Research has shown ticks are more efficient at transmitting this disease than flies, which makes sense if they are replicating in the tick and the concentration is higher. Vomits also play a role in mechanical transmission. We do know that needles are very effective in transmitting this disease. Syringes have been shown to spread *Anaplasma* (https://www.drovers.com/contributor/gregg-hanzlicek-dvm-phd-director-production-animal-field-disease-investigations-kansas).

It is spread through tick bites or by the mechanical transfer of fresh blood from infected to susceptible cattle from biting flies or by blood-contaminated vomits including needles, ear tagging, dehorning and castration equipment.(Aubry,2011).

Transplacental transmission Trans placental transmission occurs when the organism is transmitted from dam to fetus. This transmission appears to occur during the second or third trimester of pregnancy. In one study, 10 percent of calves born to infected cows were infected at birth; 7 in another, 16 percent were born infected (Grau*etal.*,2013).

1.5.3 Clinical signs:

Are related to the number of infected red blood cells, and animals may exhibit a combination of the following symptoms: fever, depression, poor appetite, constipation, jaundice, nervousness, abortion in pregnant animals, and death (Kocan*et al.*, 2010).

1.5.4 Diagnosis:

The Gold Standard diagnostic for determining *Anaplasma* infection is to take blood out of that animal and inject it into a calf that has its spleen removed, but that test is limited to research applications. Veterinarians generally use blood smears; ELISA is a serum antibody test. PCR is an antigen test looking at ribosomal RNA (https://www.drovers.com/contributor/gregg-hanzlicek-dvm-phd-director-production-animal-field-disease-investigations-kansas).

Demonstration of *A. marginale* on stained blood smears from clinically infected animals during the acute phase of the disease, but it is not reliable for detecting infection in pre-symptomatic or carrier animals. In these instances, the infection is generally diagnosed by serologic demonstration of antibodies with confirmation by molecular detection methods. (Aubry andGeale,2011).

1.5.5Treatment:

Long-acting injectable oxytetracycline is the antimicrobial most often used for treating Anaplasmosis. However, oxytetracycline is not labeled for this use and so must be prescribed by the herd veterinarian. (Coetzee *et al.*,2005).

1.5.6 Control:

There is an experimental killed vaccine available in some states. The vaccine does not prevent infection, but reports from the fields suggest it reduces clinical signs and reduces cow and bull death losses(https://www.drovers.com/contributor/gregg-hanzlicek-dvm-phd-director-production-animal-field-disease-investigations-kansas).

Control methods for anaplasmosis have not changed markedly during the past 50 years and include arthropod control, chemoprophylaxis, vaccination, and maintenance of an *Anaplasma*-free herd. Control measures implemented vary with geographic location, and depend on availability, cost, and the feasibility of application (Kocan, 2000).

The strategies commonly employed to control Anaplasmosis are minimizing transmission, use of feed antimicrobials, and vaccination (Coetzee *et al.*,2005).

1.6 Rickettsia (*Cowderiaruminatum*):

Is tick borne disease in sheep goat and cattle and wild ruminants? Which is caused by *rickettsia* (*cowdriaruminantum*) recently called *Ehrilichiaruminantum*. The disease is characterized by high fever, nervous signs, hydro pericardium, hydrothorax,odema in lung and brain and death is major cause of stock losses in sub-SaharanAfrica. (Allsopp*et al.*,2005).

1.6.1Etiology:

This is caused by *Ehrilichiaruminantum* is pleomorphic rickettsia and colonies Containing from one to two several thousand when individual organism are found in cytoplasm of endothelial cell the shape of colonies is coccoid but in very large colonies is pleomorphic form (horse shoe -ring and bacillary shaped) is gram negative bacteria and stain purplish blue with giemsa. The development of organism in the epithelium of the intestine of tick and salivary glands the transmitted after tick have attached to susceptible animals is between 27 -38 hoardin nymph and between 51-75hours in adult (Allsopp*et al.*,2005).

Ehrlichiaruminantium (formerly *Cowdriaruminantium*). Order *Rickettsiales*, Family *Anaplasmataceae*. Small, Gram negative, pleomorphic coccus, and obligate intracellular parasite. Strains of *E. ruminantium* are very diverse and vary in virulence: while some strains are highly virulent, others appear to be less-

pathogenic. *E. ruminantium* has a high level of genomic plasticity. Several different genotypes can co-exist in a geographical area, and may recombine to form new strains.*E. ruminantium multiplies* in vascular endothelial cells throughout the body to cause severe vascular compromise (Brown,2008).

1.6.2 Transmission:

Heart water is transmitted by ticks of genus *Amblyomma*they are three host tick. Larvae and nymphs become infected when the fief of on domestic and wild ruminant and possibly also on certain game birds and reptiles at time when *E. Ruminantum* is circulating in the blood of these host. The immature stage of tick commonly fords on smeller species of domestic and wild ruminant and game birds. Nymph or adult tick transmitted *E. Ruminantum* to susceptible host without losing of infection. interstadial transmission has been demonstrated and transovarialtransmission demonstrated in heavy infected tick under laboratory conditions unlikely that occur in the field... Heart water occuronly where it's vectors are present and 10 *Amblyommaspp* capable to transmitting the organism in Africa. The major vectors is*A. Varigatum*and*A.Hebraeum*(Allsopp*et al.*,2005). Heart water is transmitted transstadially by ticks of the genus *Amblyomma,* which are biological vectors of heartwater. Ticks become infected by feeding on acutely ill or sub clinically infected animals. Heart water can be transmitted vertically and through colostrum of carrier dams, transmissioncan also occur by intravenous inoculation of blood, tick homogenates or cell culture material containing *E.ruminatium*(Fauquet *et al.*,2005).

1.6.3 Clinical signs:

The infected domestic ruminant may have manifested a wide range of clinical signs, incubation period, course, severity and outcome of artificially -induced disease are influenced by the species, breed, age of animals affected, the route of infection, the virulence of strain of *E. Ruminantum* and amount and source of infective material administered Per a cute, acute, sub-acute and clinically unapparent form of disease occurs. Death usually follows in animal show clinical signs if they are not specifically treated for heart water. The incubation period in affected cattle between9to29 days the average is18day especially in advance stage of pregnancy pracutelly affected animal die within a few hours after initial development of fever. Acute heart water most common form of cattle age of three and 18month characterized by fever40 c or higher certain bread develop diarrhea perfuse hemorrhagic diarrhea is most prominent clinical sign in some cases of heart water Nervous signs in later stage (in coordination to consultation), the animal difficult to handling by human, fall down and lateral

rucumbency and opisthotonous and death. The subacuteform: high fever, remain 10 days or longer incubation period from 5-35days. More in sheep than cattle most animal collapse suddenly adie after a few paroxysmalconvulsions.Acute heart water common in sheep and goats less than cattle manifested by nervous signs, fever, progressive unsteady gait and stand with their legs wide apart with head lower and ears drooping eventually become prostrate and lateral recumbence, opisthotonous licking of lips and nystagmus several hydrocardium and hydrothorax in some cases degree of as cites the mucous membrane are often congested and contain petechial and ecchymosisodema in brain (Allsopp et al.,2005).

1.6.4 Diagnosis:

Clinical signs and pathology, laboratory confirmation postmortem diagnosis by light microscopy of *E. Ruminantum* in the cytoplasm ofendothelial cells of blood vessels in stained brain tissue, isolation of organism from brain and kidney. Various stain use for heart water stain by gismsia or CAm's Quick stain , slightly reduction of hemoglobin and Hematocrit values in sheep, goats and calves, type of an anemia is usually normocytic and normochromic mild Leukopenia mainly neutrophil, histopathology for kidney and brain, serological test such as indirect fluorescent anti body and Enzyme linked immunosorbent assay .Laboratory diagnosis, sample from blood and brain, identification of agent (*E .ruminatium*) ,PCR and ELISA (OIE,2009) .

1.6.5 Control and prevention:

Tick borne control mean heart water control. After infected blood based vaccine developed. Regulation of number of tick presents as to prevent the debilitating effect of several tick infestations several drugs used to treat animals suffering from heart water but tetracycline especially oxytetracyline are most used injection intramuscular, systemic treatment and supportive treatment such as anti-inflammatoryagent (Allsopp*et al.*,2005).

As *E. ruminantium* cannot survive outside a living host for more than a few hours at room temperature, heart water is usually introduced into free areas by infected animals, including subclinical carriers, or by ticks. In heart water-free countries, susceptible ruminants from endemic regions are tested before importation. All animals that may carry *Amblyomma*, including non-ruminant species, must be inspected for ticks before entry. Ticks may be carried into a country on illegally imported animals or migrating birds. Outbreaks are usually controlled with quarantines, euthanasia of infected animals and tick control.

During an outbreak, ticks should not be allowed to feed on infected animals. Iatrogenic transfer of blood between animals must also be avoided. In endemic regions, heart water can be prevented by tick control and vaccination. Animals moved into endemic areas may be protected by prophylactic treatment with tetracycline. Vaccination currently consists of infection with a live E.*ruminantium* strain, then treatment with antibiotics when a fever develops (OIE, 2008).

1.6.6 Treatment:

In endemic areas, animals with heart water can be treated with antibiotics. Tetracycline (oxytetracycline at 10 mg/kg or doxycycline at 2 mg/kg) is effective during the early, febrile stages of this disease, but animals often die before treatment can be administered. Antibiotic treatment alone is not always successful in later stages. Vector control measures aimed at eradication of *Amblyomma* ticks by acaridae treatment of cattle and small ruminants has been successful in the context of small islands in the Caribbean but is not achievable in most situations and even not recommended. In endemic areas of Africa, tick levels are now allowed to remain at levels high enough to permit reinfection of immune animals to boost the immunity and develop endemic stability (OIE, 2008).

1.7 Theileriosis:

Is a tick-borne hem protozoan disease of cattle caused by several *Theileria* species and among them *T. parva*, the cause of East Coast fever and *T. annulata*, the causative agent of tropical theileriosisis the most pathogenic and economically important. The aim of this manuscript is to review currently available articles on the bovine theileriosis with a special attention to its control. Theileria have complex life cycles involving both vertebrate and invertebrate host. (NejashandTilahun,2016).

Tropicaltheileriosis and East Coast Fever are disease transmitted by Ixodid tick of the genus *Hyalomma* and *Rhipicephalus*, respectively. Furthermore, the sporozoites are transmitted to animals in the saliva of the feeding tick. Bovine theileriosis is characterized by high fever, weakness, weight loss, inappropriate appetite, conjunctivalpetechial, enlarged lymph nodes and anemia. (Nejash and Tilahun., 2016).

1.7.1 Etiology:

*Theileriae*are obligate intracellular protozoan parasites that infect both wild and domesticBovidae throughout much of the world, some species also infect small ruminants. They are transmitted by ixodid ticks, and have complex life cycles in both vertebrate andinvertebrate hosts. There are six identified *Theileriaspp*. that

infects cattle; the two most pathogenic andeconomically important are *T. parva* and *T. annulata*. *T. parva* occurs in Eastern and Southern Africa and causes East Coast fever (ECF or Corridordisease).*T. annulata* causes tropical theileriosis (TT), also known as Mediterranean theileriosis and occursin North Africa, southern Europe and Asia. *T. lestoquardi* (*T. hirci*) is the only species of economic significance infecting small ruminants, andit occurs in the Mediterranean basin, North Africa and Asia. Most *Theileriae* are confined to Asia or Africa corresponding to the geographical distribution oftheir vector ticks, except for the worldwide distribution of the a pathogenic*Theileriae*(OIE,2008).

1.7.2 Transmission:

Both *T. parva* and *T. annulata* are spread by ticks. The most important vector for *T. parva* is *Rhipicephalusappendiculatus*. *R. zambeziensis* insouthern Africa and *R. duttoni* in Angola can also spread East Coast fever. *T annulata* istransmitted by ticks of the genus *Hyalomma*. Ticks can remain infected on the pasture for up to 2 years depending on the climatic conditions. Disease is not maintained in the absence of these field vectors.Theileriasporozoites are transmitted to susceptible animals in the saliva of the feeding tick. Ordinarily, *T. parva* and *T. annulata* only mature and enter the saliva after the tick attaches to a host. Usually, a tick must be attached for 48–72 hours before it becomes infective. However, ifenvironmental temperatures are high, infective sporozoites can develop in ticks on theground

and may enter the host within hours of attachment. Transovarial transmission does not occur with either *T. parva* or *T. annulata*.Inside the host, Theileriasporozoites undergo a complex life cycle involving the replication ofschizonts in leukocytes and periplasms in erythrocytes. Cattle that recover from Theileria infections usually become carriers (Nejash and Tilahun ,2016).

1.7.3 Clinical Signs:

Generalized lymphadenopathy, fever, anorexia and loss of condition withdecreased milk yield. Petechial and ecchymosis may be found on the conjunctivaand oralmucous membranes. Lacrimation, nasal discharge, corneal opacity anddiarrhea can also be seen. Terminally ill animals often develop pulmonaryodema, severe dyspnea and a frothy nasaldischarge. Some cattle have afatalcondition called “turning sickness.” In this form of thedisease, infected cells block capillaries in the central nervous system and cause neurological signs. Animals thatrecover from East Coast fever often become asymptomaticcarriers, but some animals have poor productivity and their growth isstunted.Tropical theileriosis generally resembles East Coastfever, but these parasites also destroy red blood cells, causing jaundice ,anemia, and in some casehemoglobinuria. Hemorrhagic diarrhea may be seen in thelate stages. Petechial are often found on the mucous membranes .Neurological signs have been documented in some terminally ill water buffalo but “turning sickness” does not seem to be a feature

of tropical theileriosisincattle. Abortions can be seen other species of Theileria including *T. mutans,T. sergenti* and *T. buffeli* can cause anemia in cattle or increasethe severity of clinical signs in animals coinfected with *T. parva* or *T . annulata*. On their own, these organisms usually because mild disease compared toEast Coast fever or tropicaltheileriosisSome species such as *T. velifera* appear to be non-pathogenic.*T .lestoquardi* is the most virulent species in small ruminants, and oftencausefatal disease (Brown,2008).

1.7.4 Diagnosis:

Diagnosis of clinical disease caused by Theileria usually relies on clinical parameters and microscopicconfirmation of the presence of parasites, either in smears of needle aspirates from enlarged lymph nodes or bloodsmears. Definitive identification of the Theileria species involved sometimes requires the application of species-specific PCR assays(Odongo*et al.*,2010).

Antibody tests based on enzyme-linked immunosorbent assays employing recombinantimmunedominantschizontproteins (pennekeret *al.*,2009).

As well as species-specific PCRs, are frequently used in epidemiological studies. A reverse line blot assay involving PCR amplification of a segment of the 18s ribosomal RNA subunit of all *Theileria* and *Babesia*species and subsequenthybridization of the amplicons with species-specific oligonucleotides has been employed to identify Theileria species present in individual animal sample (Gubbles*et al.*, 1999).

Differential diagnosis:

• Heart water
• Trypanosomosis
• Babesiosis
• Anaplasmosis
• Malignant catarrhal fever
• Contagious bovine pleuropneumonia
•The parasites must also be differentiated from other species of *Theileria* (OIE , 2008).

1.7.5 Treatment:

According to OIE chemotherapeutic resistant to ecto parasites than are Bostaurus animals. agents such as parvaquone, buparvaquone and There are great differences between these two breeds of halofuginone are available to treat *T. annulata* and

cattle in regard to their susceptibility to parasitism by *T. parva* infections. These best Theilericidaldrugscattleticks. In general sense rearing disease-resistant belong to the hydroxyl naphthoquinonesfamily.breeds play significant role in controlling bovine Naphthoquinone compounds were discovered in 1970 theileriosis. Hence selection of cattle breeds with a wide therapeutic index. Thesenaphthoquinones enhanced tick resistance is proposed as a sustainable

compound is not only effective for curing theileriosis tactic for controlling infection in developing world.But can also be used as a remarkable prophylactic (Nejashand Tilahun, 2016).

1.7.6 Control:

Theileriosis is not transmitted by casual contact. If the infection is newly introduced to an area. In endemic areas, the tick burden can be decreased with acaricides and other methods of tick control such as rotational grazing. The transfer of blood between animals must also be avoided. Ant parasitic drugs are effective in animals with clinical signs, but animals may remain carriers. Treatment is most effective in the early stages of the disease. Animals can be protected from both East Coast fever and tropical theileriosis by vaccination. Attenuated vaccines are used to control tropical theileriosis in some countries. Vaccination against East Coast fever is done by simultaneously injecting virulent *T. parva* and an antibiotic (usually a long-acting tetracycline). This process generally results in a mild or inapparent infection, and the animal becomes a carrier. *T. parva* stocks that infect cattle asymptomatically have been identified, and might be used without simultaneous antibiotic therapy. Considerations in *T. parva* vaccination include the possibility of introducing live organisms into areas where they are not currently endemic (OIE, 2009).

Public health:

There is no evidence that *T. parva* or *T. annulata* are hazards to humans. (OIE, 2009).

Chapter Two

Chapter Two

Materials and Methods

2.1 Study area:

Khartoum state islocated in Central Sudan, comprising the semi–arid zone between the latitude 15.08 N to 16.39 N and longitude 31.36 E to 34.25 E. The system of animal breeding or animal production in this area is General semi intensive depending on natural range in the vicinity of the villages and the town outskirts as well as individual houses. However, different intensive systems have recently been introduced in animal nutrition, improvement of breeds and its productivity, proper administration and farm management raising the economic status of these livestock particularly specialized farms. Moreover, there are various breeds of these animals such as kenana, butana, cross breeds and frisian for cattle; Nubian, desert, cross, saaneenand other foreign for goats. Similarly, there are different types of sheep, camels and poultry, horses, donkeys, deer, dogs and cats.

2.2 Study population:

Most of domestic animals including Bovine, Ovine, Caprine, Deer, Equine, canine.

2.3 Study design:

A cross sectional study was conducted to estimate prevalence of tick and tick borne parasites.

2.4 Data collection and statistical analysis:

2.4.1 Data collection:

The data was collected from recorded cases in different area in Khartoum localities in 2016 & 2017.Bahri locality from Alcadarow hospital, Omdormanlocality,fromHai Al Arab hospital. Khartoum locality from Soba, Stablate,Alremala, Al lamab, Al shajara, Al goze, Al Helaa Algadeda, Al kalakla, Al Jabal, Jabrah, Al Nozha, Al Sahafa, Al Deem, Al Taeif, Arkaweet.

2.4.2 Statistical analysis:

The record data was transferred into a Microsoft Excel spreadsheet. Descriptive statistics.The data collected from record cases were analyzed using descriptive statistical methods. Association between a potential risk factors and proportion of disease–free herds and infected herds was expressed by the odds ratio (OR) Chi-square test was used for univariate analysis with P-value of 0.25, and each factorwith P-value equal or lessthan 0.25 was entered to multivariate analysis

which was done by Logistic Regression and each factor in multivariate analysis with P-value less than or equal to 0.05 was considered statistically significant.

Chapter Three

Results:

Table (3): **The number of animals according to the species investigated in each locality of Khartoumstate.**

As shown in table (3) Khartoum locality showed high incidence of blood parasite, this followed by Omdurman and the least was Bahri.

State	species							Total
	Bovine	Canine	Equine	Caprine	Ovine	Camel	7	
Bahri	36	0	4	36	14	1	3	94
Omdurman	0	0	147	0	0	0	0	147
Khartoum	115	42	51	13	14	1	0	236
Total	151	42	202	49	28	2	3	477

As shown in figure (9) in Khartoum the incidence of infection was high in bovine followed by equine,canine,ovine,caprine and the least was camel.
In Omdurman the high incidence of infection was high in equine.
In Bahri the incidence of infection was high in bovine and caprine, followed by ovine, camel and least was equine.

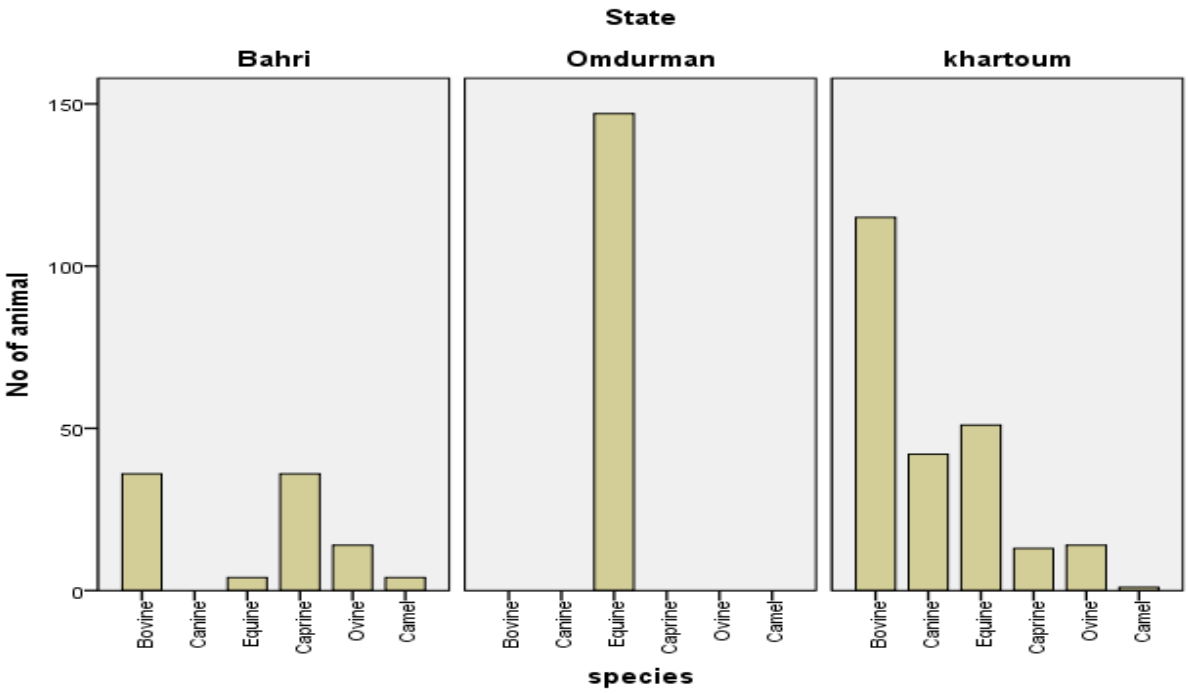

Figure (9): **shows the number of animal infected with tick borne diseases according to species.**

Table (4): The type and number of incidence of tick borne diseases in Khartoum State.

As shown in this table (4*) Babesia* was of high incidence in Khartoum followed by Omdurman then Bahri. *Theileria* was of high incidence in Khartoum followed by Bahri then Omdurman.*Anaplasma* was of same incidence in Omdurman and Khartoum and absence in Bahri. Tick infection was of high incidence in Khartoum and absence in Bahri and Omdurman. The mixedinfection was high in Bahri.

State	Type of disease							Total
	Babesia	Theileria	Anaplasma	Tick infection	Babesia + Theileria	Babesia + Theileria + Anaplasma	Theileria + Anaplasma	
Bahri	27	35	0	0	9	21	2	94
Omdurman	113	32	2	0	0	0	0	147
khartoum	132	56	2	46	0	0	0	236
Total	272	123	4	46	9	21	2	477

As shown in Fig (10) in Khartoum,*Babesia*was of high incidence followed by *Theileiria*, tick infection and *Anaplasma*. In Omdurman Babesiawasof highincidence followed by *Theileiria* then *Anaplasma*. In Bahri*Theileria*was of high incidence followed by *Babesia* mixed (*Babesia+Theiieria +Anaplasma*) , mixed disease (*Babesia+Therileria*), mixed disease (*Theileria+Anaplasma)*was recorded in the three localities.

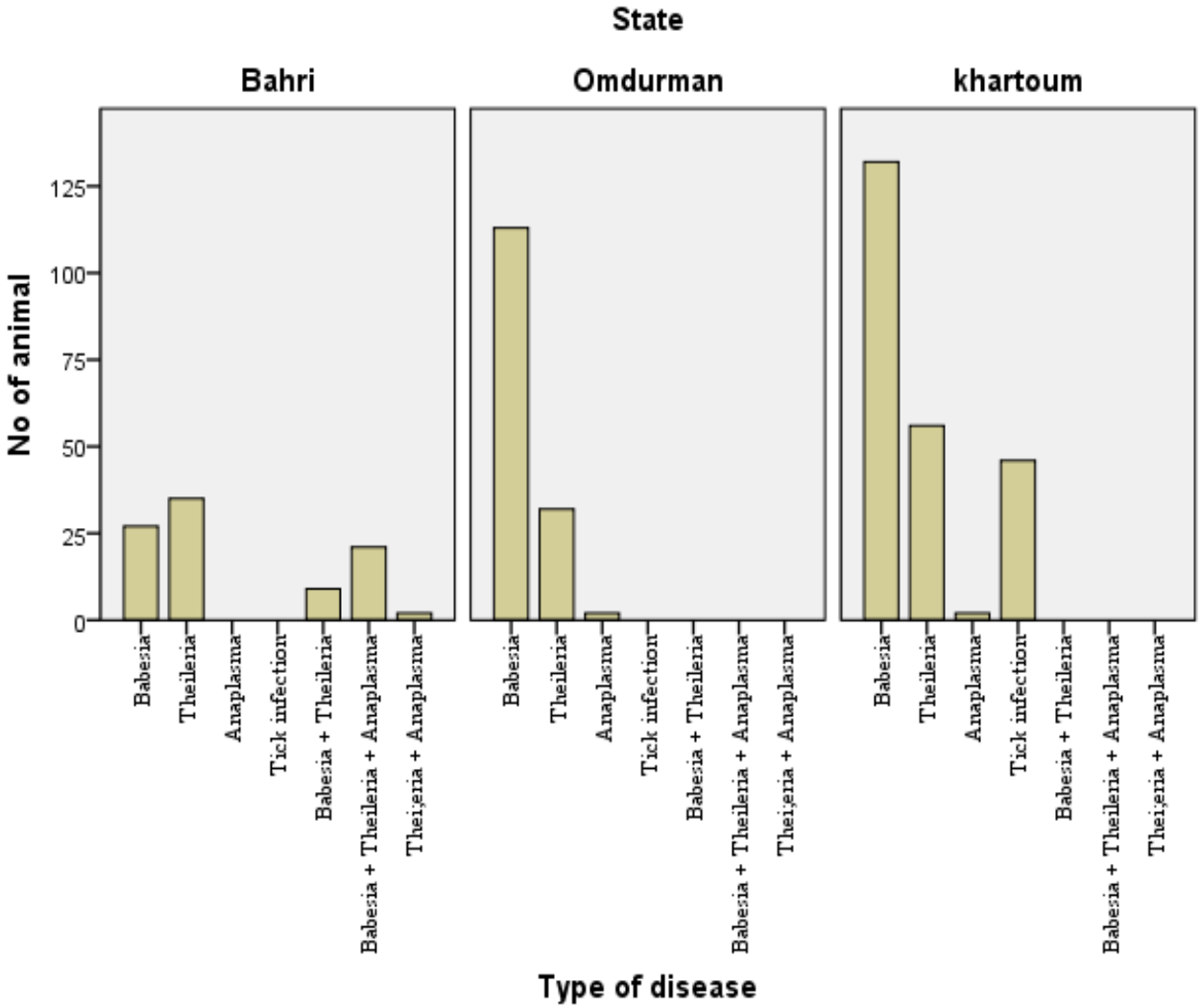

Figure (10): The number and incidence in each type of disease in the three localities.

Table (5): The type of tick born disease in each area of Khartoum locality.

As shown in table (5) Haialarab showed high incidence of Babesia and *Anaplasma,*Altaaif and Arkweet showed high incidancof Theiliriosis ,Alsahafa +Aldeem showed high incidence of tick infection , Akadaro hospital was high of incidence of mixed infection .

Area	Type of disease							
	Babesia	Theileria	Anaplasma	Tick infection	Babesia + Theileria	Babesia + Theileria + Anaplasma	Theileria + Anaplasma	Total
Soba	8	2	0	2	0	0	0	12
Alestablat	30	2	0	1	0	0	0	33
Alremela+ Allamab	36	4	1	1	0	0	0	42
Alshagara	5	1	0	2	0	0	0	8
Algooz+ AlhelaAlgadeda	0	0	1	12	0	0	0	13
Alkalakla+ Algabal	46	9	0	4	0	0	0	59
Jabra+ Alnozha	1	0	0	9	0	0	0	10
Alsahafa+ Aldeeem	4	2	0	13	0	0	0	19
Altaaif +Arkaweet	2	36	0	2	0	0	0	40
Alkadaro hospital	27	35	0	0	9	21	2	94
haiAlarab Hospital	113	32	2	0	0	0	0	147
Total	272	123	4	46	9	21	2	477

Table (6): The type of tick born disease in according to the year (2016-2017)

As shown in table (6) there was high incidence of infection by *Babesia* in 2017 and also high incidence of *Theileria*. Other diseases were recorded but of lower incidence.

Year	Type of disease							
	Babesia	Theileria	Anaplasma	Tick infection	Babesia + Theileria	Babesia + Theileria + Anaplasma	Thei;eria + Anaplasma	Total
2016	77	28	2	27	2	12	0	148
2017	195	95	2	19	7	9	2	329
Total	272	123	4	46	9	21	2	477

As shown in Fig (11) the high incidence of infection in 2016 was *Babesia*,*Theilria*and tick infection, mixed infection (*Babesia+Theileria+Anaplasma*), mixedinfection(*Babesia+Theileria*) and *Anaplasma*. In2017 there was high incidence by *Babsia*, *Theileria*, tick infection, mixed infection (*Babesia=Thileria+Anaolasma*), mixedinfection*(Babesia+Theileria*) and least infection by*Anaplasama* and mixed infection (Theilleria *+Anaplasma*).

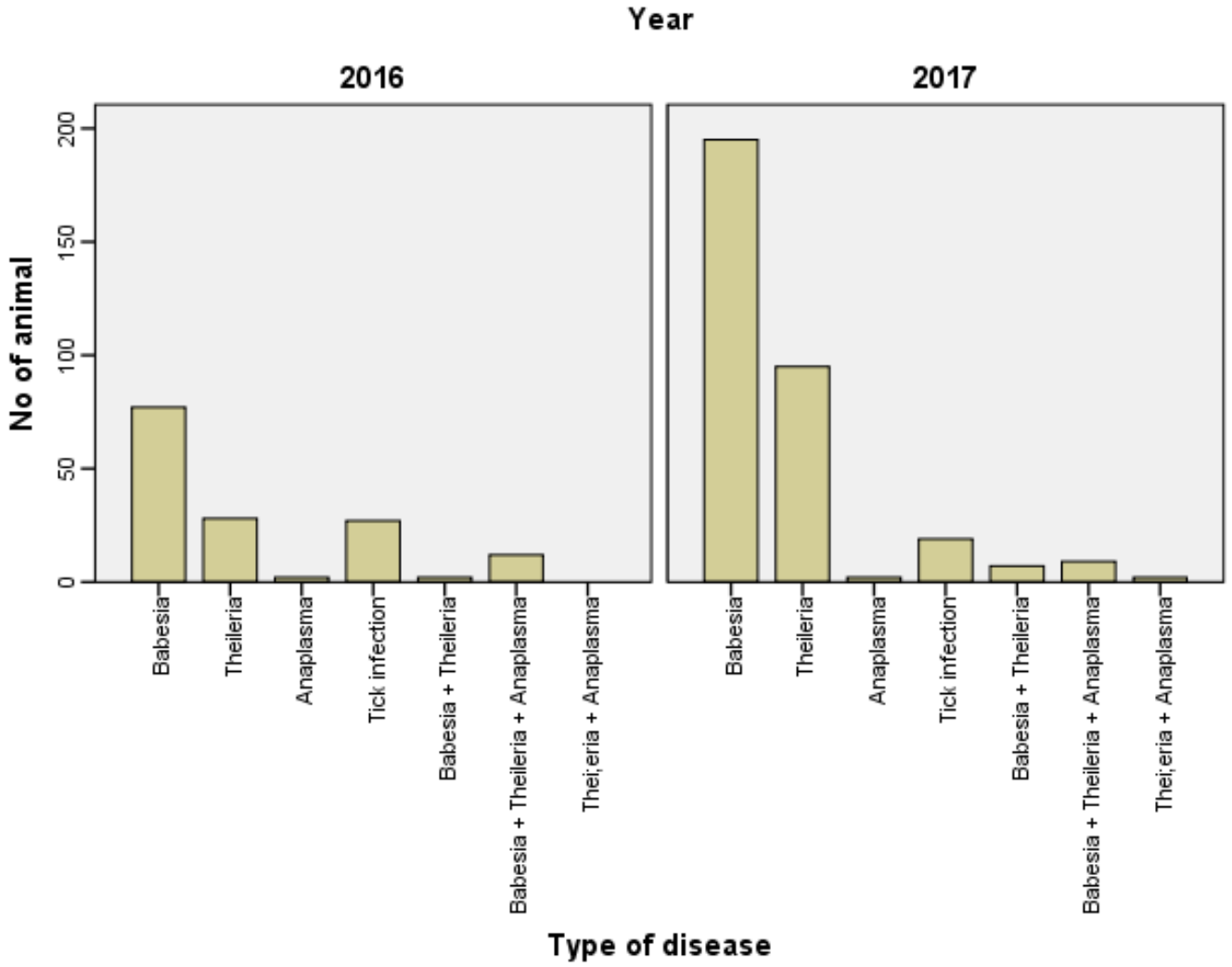

Figure (11): The incidence of tick borne diseases in the year 2016-2017.

Table (7): The type of tick bornediseases according to the month of the year

As shown in table (7)*Babesia* was of high incidence in December,*Theileria*was also of high incidence in December,*Anaplasma* was high incidence in September, tick infection was high incidence in March,*Babesia +Thileria* was high incidence in December,*Babesia +Theileria+Anaplasma* was high incidence in September,*Theilaria +Anaplasma* was high incidence in December.

month	Type of disease							Total
	Babesia	Theileria	Anaplasma	Tick infection	Babesia + Theileria	Babesia + Theileria + Anaplasma	Theileria + Anaplasma	
January	25	1	0	3	0	0	0	29
February	14	0	0	6	0	0	0	20
March	14	1	1	11	0	0	0	27
April	12	1	1	4	0	0	0	18
May	13	0	0	3	0	0	0	16
June	11	10	0	4	0	0	0	25
July	48	19	0	2	0	0	0	69
August	21	0	0	3	0	5	0	29
September	21	2	2	2	0	8	0	35
October	25	13	0	2	0	4	0	44
November	17	2	0	1	1	2	0	23
December	51	74	0	5	8	2	2	142
Total	272	123	4	46	9	21	2	477

Table (8): The type of tick borne diseases based on the species of animals

As shown in table (8) *Babesia* was of high incidence in equine,*Thileria*was of high incidence in bovine,*Anaplasma*wasof high incidence in equine, tick infection was of high incidence in canine,*Babesia +Thileria* was of high incidence in bovine and ovine,*Babesia +Thileria+Anaplasma*wasofhigh incidence in ovine, *Tthileria +Anaplasma* was of high in caprine.

	Type of disease							
	Babesia	Theileria	Anaplasma	Tick infection	Babesia + Theileria	Babesia + Theileria + Anaplasma	Theileria + Anaplasma	Total
Bovine	76	62	1	1	3	8	0	151
Canine	0	0	0	42	0	0	0	42
Equine	160	35	3	2	1	1	0	202
Caprine	23	18	0	0	2	4	2	49
Ovine	11	8	0	0	3	6	0	28
Camel	2	0	0	1	0	2	0	5
Total	272	123	4	46	9	21	2	477

Table (9-a) Shows the statistical analysis of incidence of the diseases as related to the state, locality. Year, month and the species of animals.

Correlations

		State	Area	Year	month	species	Type of disease
State	Pearson Correlation	1	-.690**	-.005	-.276**	-.357**	-.234**
	Sig. (2-tailed)		.000	.905	.000	.000	.000
	N	477	477	477	477	477	477
Area	Pearson Correlation	-.690**	1	-.094*	.013	.159**	.085
	Sig. (2-tailed)	.000		.039	.784	.000	.065
	N	477	477	477	477	477	477
Year	Pearson Correlation	-.005	-.094*	1	.271**	-.212**	-.167**
	Sig. (2-tailed)	.905	.039		.000	.000	.000
	N	477	477	477	477	477	477
month	Pearson Correlation	-.276**	.013	.271**	1	.002	.062
	Sig. (2-tailed)	.000	.784	.000		.963	.178
	N	477	477	477	477	477	477
species	Pearson Correlation	-.357**	.159**	-.212**	.002	1	.054
	Sig. (2-tailed)	.000	.000	.000	.963		.240
	N	477	477	477	477	477	477
Type of disease	Pearson Correlation	-.234**	.085	-.167**	.062	.054	1
	Sig. (2-tailed)	.000	.065	.000	.178	.240	
	N	477	477	477	477	477	477

Table (9-b)

Correlations

		State	Area	Year	month	species	Type of disease
State	Pearson Correlation	1	-.690**	-.005	-.276**	-.357**	-.234**
	Sig. (2-tailed)		.000	.905	.000	.000	.000
	N	477	477	477	477	477	477
Area	Pearson Correlation	-.690**	1	-.094*	.013	.159**	.085
	Sig. (2-tailed)	.000		.039	.784	.000	.065
	N	477	477	477	477	477	477
Year	Pearson Correlation	-.005	-.094*	1	.271**	-.212**	-.167**
	Sig. (2-tailed)	.905	.039		.000	.000	.000
	N	477	477	477	477	477	477
month	Pearson Correlation	-.276**	.013	.271**	1	.002	.062
	Sig. (2-tailed)	.000	.784	.000		.963	.178
	N	477	477	477	477	477	477
species	Pearson Correlation	-.357**	.159**	-.212**	.002	1	.054
	Sig. (2-tailed)	.000	.000	.000	.963		.240
	N	477	477	477	477	477	477
Type of disease	Pearson Correlation	-.234**	.085	-.167**	.062	.054	1
	Sig. (2-tailed)	.000	.065	.000	.178	.240	
	N	477	477	477	477	477	477

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table (10- a)

State * Type of disease

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	208.115[a]	12	.000
Likelihood Ratio	201.602	12	.000
Linear-by-Linear Association	25.979	1	.000
N of Valid Cases	477		

Table (10- b)

Area * Type of disease

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	565.277[a]	60	.000
Likelihood Ratio	426.897	60	.000
Linear-by-Linear Association	3.407	1	.065
N of Valid Cases	477		

Table (10- c)

Year * Type of disease

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.910[a]	6	.000
Likelihood Ratio	28.599	6	.000
Linear-by-Linear Association	13.311	1	.000
N of Valid Cases	477		

Table (10-d)

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.910[a]	6	.000
Likelihood Ratio	28.599	6	.000
Linear-by-Linear Association	13.311	1	.000
N of Valid Cases	477		

a. 5 cells (35.7%) have expected count less than 5. The minimum expected count is .62.

month * Type of disease

Table (10-e)

species * Type of disease

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	549.748[a]	30	.000
Likelihood Ratio	349.862	30	.000
Linear-by-Linear Association	1.382	1	.240
N of Valid Cases	477		

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As shown in fig (12): Infection with one disease was found in about 450 animals while infection with more than two diseases was of less occurrence, only in 50 animals.

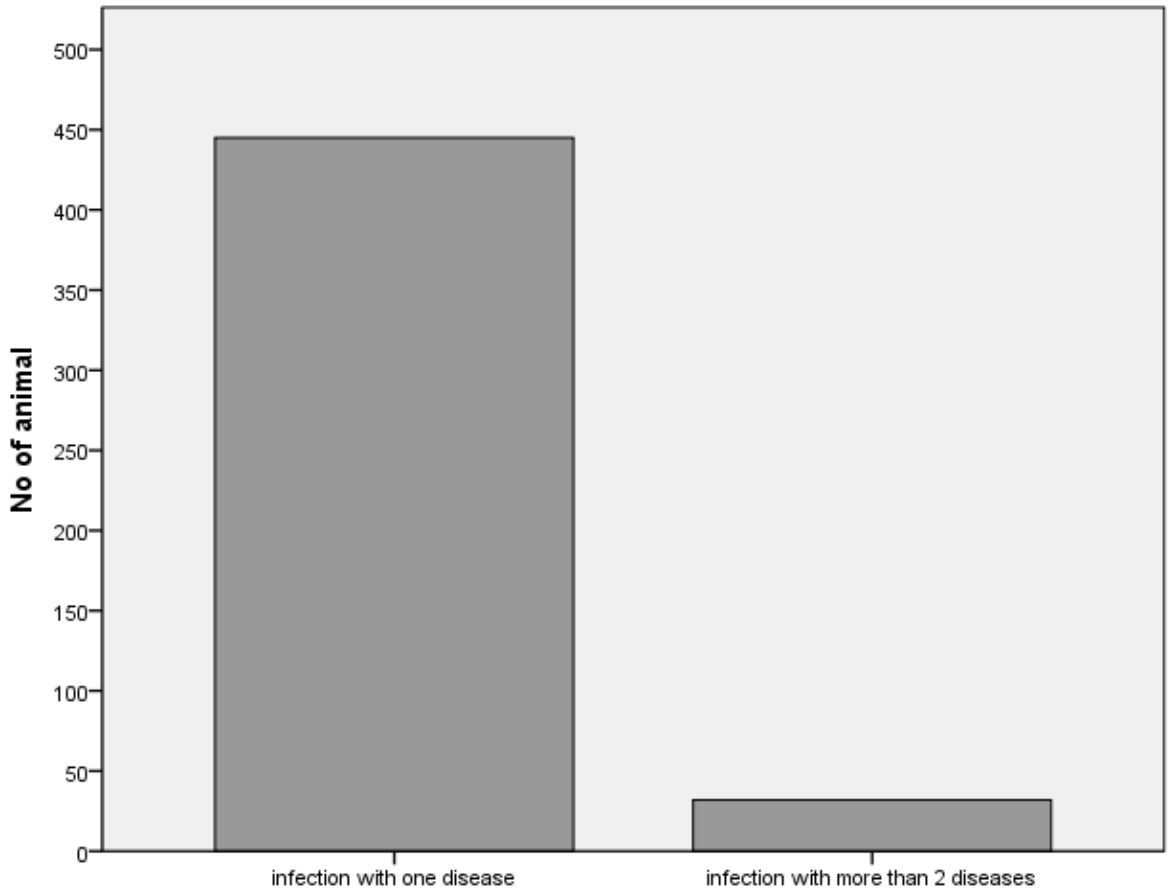

Fig (12): Showing the number of animals infected with one disease or of mixed infection (infection with more than one).

Chapter Four

Discussion:

In the present study the two type of tick were recorded in Khartoum state, this result confirms the previous study which indicated the presence of all types of the main genera of ticks in sudan*(Boophilus, Dermacentor, haemaphysalis, Hyalomma, Ixodes, Rhipicephalus*and *Amblyomma*) ().

In the present study bovine was the most infected with blood parasites. This agrees with the finding of (El Hussein *et al.*, 2012).*Theileria*was recorded in the three localities of Khartoum state, *Theileria*in sudan was recorded by (Safieldin ,2005).Also *Theileria*was reported in Sudan as the cause of major economic loss in dairy production (El Hussein *etal.*, 2012).

In the present study *Babesia*and *Anaplasma*was were found in most of animal species, this agrees with (Osman,1976) who recorded the incidence of the disease in most bovine in Sudan. In this study *Babesia and*tickswere recorded in Khartoumstate, the presence of ticks was also reported in Sudan (Bushar, 2013).

In this study *Anaplasma* was recorded indifferent animal species in Khartoum state, this agrees with finding of (Awad*et al.*,2011). In this study it was found that the month of the year had no statistical effect on the occurrence of the blood parasites. This finding is contrast to that reported by (Elnaeem, 2005). Statistical analysis showed significance association between the occurrence of the ticks and blood parasites and the state and year, this is in accord with the findings of (Awad*et al.*,2011). Who reported the significant effect of the type of state on the occurrence of tick and blood parasites in Sudan.

Conclusion:

In the current study the incidence of tick and blood parasites in different animals species in Khartoum state Localities were investigated. It was found that all of the tested animals were infected with different blood parasites with variable percentage of incidences. These included *Babesiaspp*,*Thieleriaspp*and *Anaplasmaspp*.Ticks also were found in all localities, this indicated that these diseases are endemic in the study areas.

Recommendations:

1-The use of recent methods for diagnosis of bloodparasites.
2-Implementation of national program for efficient control of ticks and tick-borne diseases.
3-Large scale research project should finance for proper outcome.

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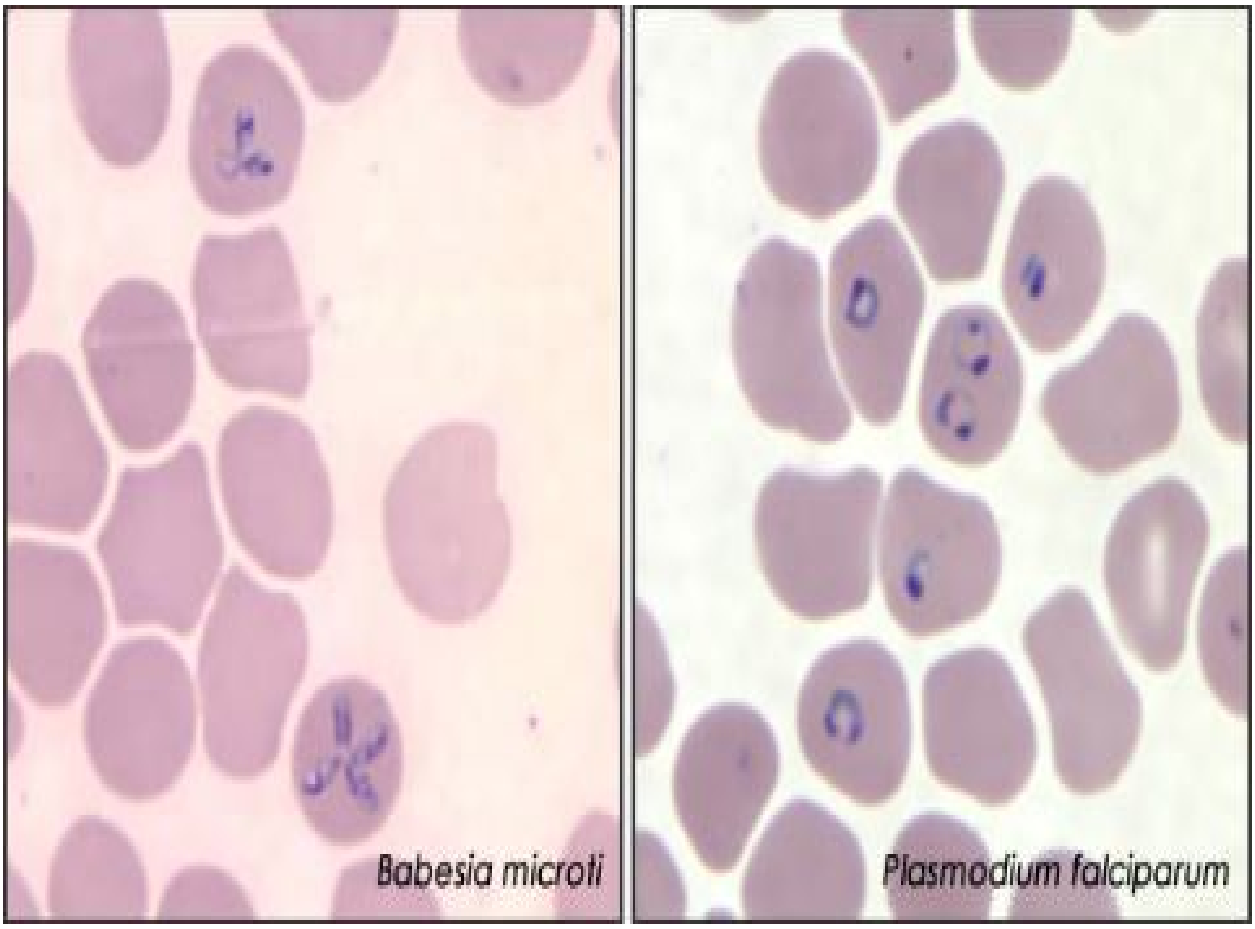
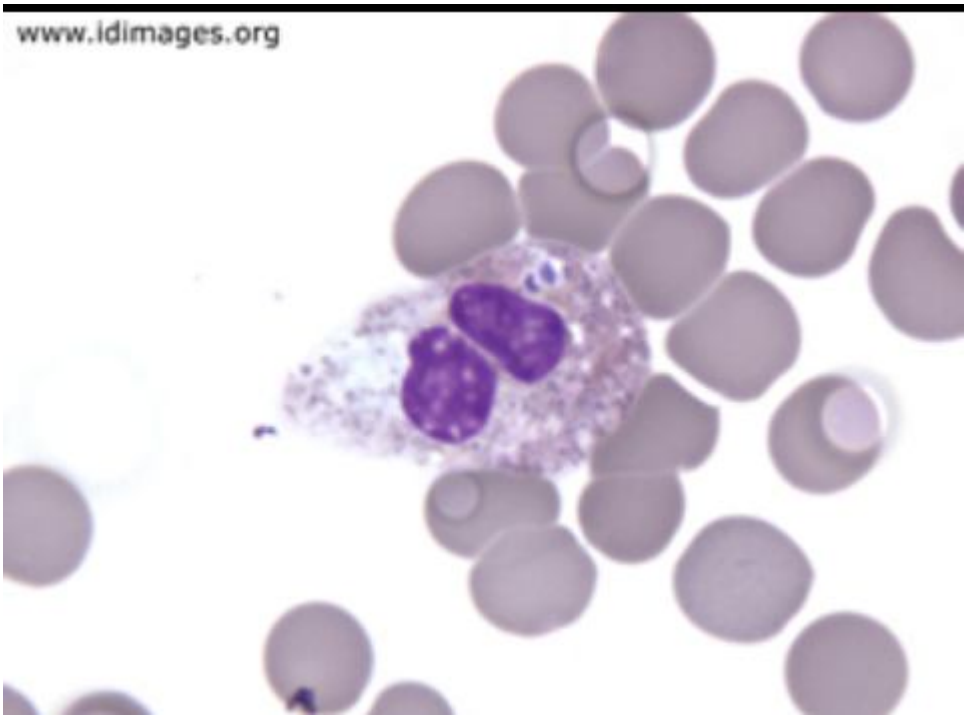

Babesia microti
Plasmodium falciparum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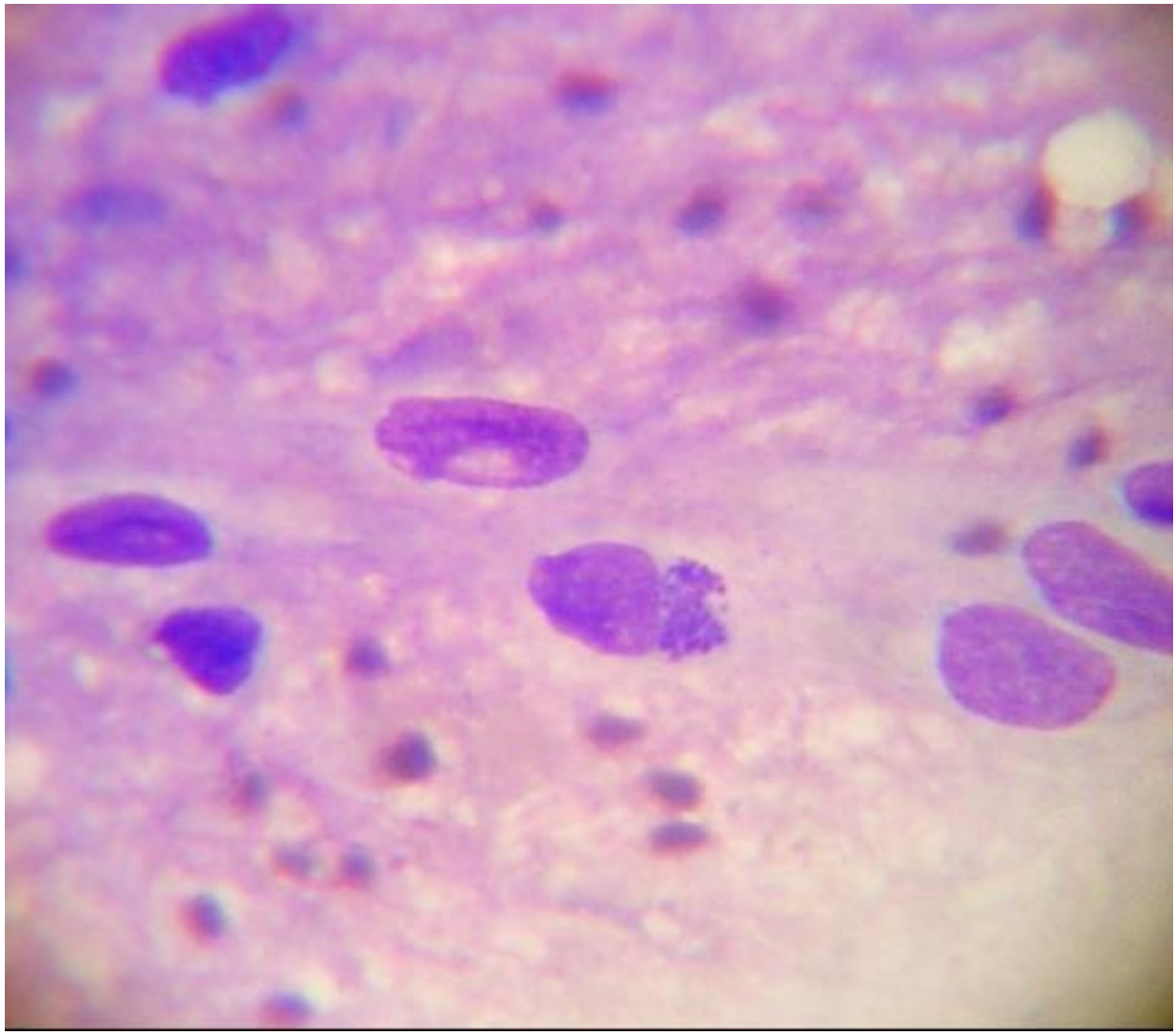

Swollen lymph node in a theileria infected calf.