



Study of the Dynamics of Distribution, Seasonality, and Degree of Infection with Bovine Theileriosis in the Territory of Turkestan Region

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Article History: 21-685

Received: 20-Aug-22

Revised: 27-Sep-22

Accepted: 30-Sep-22

ABSTRACT

The relevance of the study is conditioned by the need for rational planning and timely implementation of therapeutic and preventive measures with cattle in various geographical regions, to prevent the spread of ticks and to form an objective understanding of the real features of the epizootic situation in these regions. The purpose of the study is to investigate the dynamics of the spread, the seasonality, and the degree of infection with bovine theileriosis in the Turkestan Region of the Republic of Kazakhstan. The leading approach is a combination of the method of determining the species composition of ixodic mites using the technique developed by V.I. Pomerantsev, with a practical investigation of the seasonality of the spread of ticks, through a survey of various pastures, and regular collection of ticks from cattle during a certain period of the pasture season in stationary points, to establish the species composition of ticks and the degree of contamination of pastures. The research was carried out using the capabilities of the laboratory of the Department of Veterinary Medicine of the regional veterinary laboratory and on the farms of the Turkestan Region. Practical results were obtained in the course of this study, indicating the main trends in the dynamics of the spread, seasonality, and degree of infection with bovine theileriosis in the territory of the Turkestan Region and the country as a whole. The study results and the conclusions formulated on their basis have significant practical significance for livestock workers of the Turkestan Region of Kazakhstan, whose professional duties include monitoring the condition of cattle on these farms and preventing the occurrence and spread of various epidemics among animals.

Key words: Endoglobular Parasites, Theileriosis, Anti-Theileriosis Measures, Animal Treatment.

INTRODUCTION

The livestock sector has long occupied one of the leading places in the agricultural industry of the Republic of Kazakhstan while acting as a key element of the national policy in providing the population with food and increasing the incomes of citizens through employment. In this context, the volume of consumption of livestock products per capita should be considered one of the key indicators in assessing the well-being of the state and the general standard of living of its citizens (Marchiondo et al. 2019). This determines the degree of attention to the issues of effective development of agriculture in the Republic of Kazakhstan in general and in the Turkestan Region in particular.

Huge potential opportunities for the development of the livestock sector of the Republic of Kazakhstan are predetermined by the presence of significant competitive

advantages, which include a combination of very favourable natural and climatic conditions with the proximity of sales markets, against the background of the scale of pasture lands, which as of the beginning of 2021 make up a total area of 187.55 million hectares (Kumar et al. 2022). The livestock sector of the national economy is currently in a stage of steady growth and development, the volume of agricultural production is steadily increasing every year, and its efficiency and profitability indicators are increasing (Syrym et al. 2019). To date, the country's full livestock and agricultural potential have not been unlocked. In comparison with the figures for 1991, there is a significant decrease in the number of cattle by about 1.5 times, small cattle by 2 times, pigs by 2.5 times and poultry by 4 times (Rodriguez-Vivas et al. 2018). All this is not reflected in the best way in the production of basic livestock products.

Cite This Article as: Kozhabaev M, Kuzerbaeva A, Baizhanov K, Tulemetova S and Nurkhodzhaev N, 2023. Study of the dynamics of distribution, seasonality, and degree of infection with bovine theileriosis in the Territory of Turkestan Region. International Journal of Veterinary Science 12(3): 382-388. <https://doi.org/10.47278/journal.ijvs/2022.203>

Structural analysis of the current state of the livestock sector in Kazakhstan gives grounds to assert that in recent years there has been a steady trend toward the development of animal husbandry in Kazakhstan, but at the same time, it is still very far from the level of the state of the industry in 1990. The reason for this state of affairs is the presence of a wide list of factors that determine problems in this industry and hinder its progressive development (Almazán et al. 2022).

The main reasons that hurt the dynamics of animal husbandry development in the Republic of Kazakhstan include: a decrease in the overall quality of raw materials supplied to livestock farms and, as a result, manufactured products, a low level of development of the processing industry in Kazakhstan, the lack of a well-established system of fattening and slaughtering livestock on an industrial scale, problems with compliance with established sanitary standards in the implementation of such measures, and problems with the introduction of new technological solutions in the field of agriculture and animal husbandry, combined with the presence of various, dangerous and widespread invasive diseases (Agina et al. 2020).

Of the known invasive pathologies of animals, the greatest economic damage is caused to the national economy by diseases caused by endoglobular parasites, the most dangerous of them are hemosporidial infections of cattle, spread mainly in the southern regions of Kazakhstan (Yespembetov et al. 2019). The economic damage caused by theileriosis is great and is expressed in the death of diseased animals, a decrease in meat and dairy products, a violation of reproductive ability, and additional costs for the maintenance and treatment of sick animals (Hassan et al. 2018). There is a great risk of morbidity and mortality for newly imported livestock, especially for breeding purposes, serious difficulties are created to improve pedigree and increase livestock productivity (Ram et al. 2020). The absence of etiotropic agents against hemosporidian infections and theileriosis in the region significantly complicates the implementation of effective measures to combat these invasions, in this regard, the economic damage caused by this disease remains high (Mekata et al. 2018; Zaman et al. 2020).

The main purpose of this study is to investigate the dynamics of the spread, seasonality, and degree of infection of bovine theileriosis in the Turkestan Region, which is of fundamental importance from the standpoint of assessing the prospects for the development of the entire agricultural sector of the state.

MATERIALS AND METHODS

All procedures performed in studies involving animal participants were by the ethical standards of the American Veterinary Medical Association (AVMA) Guidelines for the Euthanasia of Animals (2020). A study was approved by the National Ethics Commission of the Ministry of Health of the Republic of Kazakhstan, No. 4568-A.

The is based on a combination of the method of determining the species composition of ixod mites using the method developed by V.I. Pomerantsev, with a practical investigation of the seasonality of the spread of

ticks, by examining various pastures and regularly collecting ticks from cattle during a certain period of the pasture season in stationary points, to establish the species composition of ticks and the degree of pasture contamination. All works were carried out in the laboratory of the Veterinary medicine department of the regional veterinary laboratory and on the farms of the Turkestan Region (Fig. 1).



Fig. 1: A map of the study area.

The theoretical basis of this study consists of research papers on the peculiarities of the spread of diseases in cattle by several Kazakh and foreign researchers. To create the most objective and qualitative picture of scientific research, and to facilitate the perception of the information provided, all the developments of foreign authors, taken in the order of citation and presented in this paper, have been translated into English.

This study was carried out in several stages. At the first stage, ticks were preserved with 70% ethyl alcohol. The species composition of ixodes mites was determined by the method of V.I. Pomerantsev. The infection of cattle with theileriosis in experiments was reproduced by parenteral administration of 100-200mL of blood from donors or by planting *H. detritum* ticks infected with theileria, according to a generally accepted method. When studying the epizootiology of theileriosis, the mass distribution, the species composition of pathogens and vector ticks, the season and dynamics of the disease of cattle with theileriosis were taken into account, depending on the species composition of ticks and the period of their activity in various zones of southern Kazakhstan.

In the first stage, to investigate the seasonal dynamics of parasitisation of ixodic ticks on cattle, their species composition, and abundance, 40 animals per herd are selected annually in each epizootic zone, on which ticks were collected every 10 days in spring, summer, and autumn, and once a month in winter. In the second stage, a study of the spread of ticks was carried out by examining various pastures and regularly collecting ticks from cattle during a certain period of the pasture season in stationary points to establish the species composition of ticks and the degree of pasture contamination. In the final stage, the species composition of pathogens of blood parasitic diseases and their quantitative ratio depending on the period of the year were studied, for which 868 blood smears were taken from 120 sick animals in different months in 2019-2020.

The degree of parasitism in cattle was determined in 20 farms in 12 districts of the region, where blood smears from 510 animals were examined in various economic entities, regardless of the form of ownership. 2,640 ticks were collected in all districts to determine the genus of the species, and their infection with theileriosis and to investigate the timing of parasitisation of ticks on animals in various geographical zones. Statistical processing was carried out using the software package “Statistica 6.0”.

RESULTS

The conducted study of the dynamics of the spread, seasonality, and degree of infection with bovine theileriosis in the territory of the Turkestan Region yielded the following results. In the course of the study, the species composition of ixodes mites in the (Turkestan) South Kazakhstan region and their infection with hemosporidian infections were investigated. The results of the conducted studies are presented in Table 1.

The data presented in Table 1 indicate that in the Kazygurt, Makhtaaraal, Saryagash, Ordabasy districts of the Turkestan Region, the *Hyalomma anatolicum* tick prevails over *Hyalomma detritum* in percentage terms, and *Hyalomma detritum* prevails in other districts (Suzak, Otyrar, Sayram, and *Shardara*).

A study of the seasonal dynamics of the spread of bovine theileriosis in southern Kazakhstan has shown that the beginning of the theileriosis season coincides with the period of spring warming (March April May). The peak of the disease was noted in June-July. This period is characterised by the accumulation of ticks in the pasture and their mass attack on animals. Then there is a gradual decline in the disease, and in September, October, or November there is a decrease. In 2018, an outbreak of bovine theileriosis occurred in December in 36 cases in Makhtaaraal and 27 in the Saryagash districts.

In all mixed forms, a severe course of theileriosis was observed, with a high mortality rate. With simultaneous course with leptospirosis, the disease covers a significant number of animals in the form of enzootia (Fraumeni 2019). With mixed parasitism in the blood of *Theileria*

and *Anaplasma*, the disease takes on a protracted character, develops slowly, causing extreme exhaustion and death of the animal. A study of the seasonal dynamics of bovine theileriosis in the conditions of southern Kazakhstan showed that the beginning of the theileriosis season coincides with the period of spring warming (March April May), the establishment of favourable hydrometeorological conditions for the development of ticks. The peak of the disease was noted in June and July.

This period is characterised by the accumulation of ticks in the pasture and their mass attack on animals. Next, the disease gradually subsides and its complete attenuation is observed in the autumn months. In 2019, an outbreak of bovine theileriosis was noted in December in 42 cases in Makhtaaraal and 31 in the Saryagash districts. The theileriosis season in most of the southern districts of the region has a duration of 7 to 9 months (Makhtaaraal, Saryagash, *Shardara*, and in the foothills of the southern Tolebiisk and Kazygurt). The first cases of the disease were noted in September, much less often the disease manifested itself in October and November.

For some areas of the region, Sayram, Baydibek, and Ordabasy, the general curve of the dynamics of theileriosis is not characteristic, since the disease appears mainly in May, sometimes in April-March, and fades in August-September, isolated cases may be in October. The season of the disease will last 4-6 months, and in the Ordabasy district in some years 8 months and up to 7. The dynamics of the disease are influenced by the natural climatic conditions of the year; in some zones, they are less favourable for the development of vector ticks – *Theileria*, therefore, in some areas of the region, the *Theileria* season is even more reduced, and lasts only 2-4 months (Suzak Turkestan, Otrar). Clinically, the disease manifests itself there in May and June, the last cases were noted in June and July, rarely in August, as an exception – in September.

In general, the prevalence of ticks in the natural and climatic zones of southern Kazakhstan looks as shown in Table 2.

Potential carriers of bovine theileriosis are ticks of *H.detritum*, *H.anatolicum*, and *B.calcaratus* pyroplasmosis

Table 1: Determination and ratio of the species composition of ticks in the Turkestan Region (%) for 2018-2019

Name of districts	Number of ticks												
		<i>H.asiaticum</i>	<i>H.scupense</i>	<i>H.plumbeum</i>	<i>H.anatolicum</i>	<i>H.detritum</i>	<i>A.persicus</i>	<i>B.calcaratus</i>	<i>D.marginatus</i>	<i>R.bursa</i>	<i>I.risinus</i>	<i>D.niveus</i>	<i>H.aegyptium</i>
Baydibek	2.547	10.1	18.8	-	13.1	14.8	12.7	30.5	-	-	-	-	-
Kazygurt	2.530	-	-	-	9.3	7.9	61.8	-	-	-	-	21.0	-
Makhtaaraal	2.531	-	3.7	5.7	39.5	38.3	4.7	8.1	-	-	-	-	-
Ordabasy	2.532	-	14.8	12.4	27.5	14.8	13.63	-	-	2.17	-	12.0	2.7
Otyrar	2.527	10.6	11.6	0.9	8.7	14.6	30.2	-	2.4	-	-	20.0	1.0
Sayram	2.533	-	-	11.1	19.5	45.0	24.4	-	-	-	-	-	-
Saryagash	2.535	-	7.0	27.6	10.4	8.7	30.0	14.3	-	2.0	-	-	-
Suzak	2.529	23.0	22.0	9.6	13.0	30.0	1.2	-	1.2	-	-	-	-
Tole Bi	2.522	10.7	19.2	2.2	12.1	12.6	16.8	18.2	6.1	2.1	-	-	-
Tulkibas	2.541	7.1	23.9	-	10.8	13.1	20.2	14.7	4.5	4.7	1.0	-	-
Shardara	2.526	-	-	4.4	37.0	39.2	4.6	13.8	-	-	1.0	-	-
Arys	2.518	-	17.5	-	-	33.6	1.2	23.0	-	-	-	24.7	-
Turkestan city	2.542	-	7.5	-	-	38.4	1.3	23.1	-	-	-	29.7	-
Total	32.913	4.7	11.2	6.3	15.4	23.9	17.1	11.2	1.09	0.8	0.15	8.26	0.28

Table 2: The prevalence (%) of ticks in various Turkestan Regions

Region	<i>Hyalomma detritum</i>	<i>Hyalomma anatolicum</i>	<i>Hyalomma scupense</i>	<i>Boopillus calcaratus</i>
Makhtaraal, Shardara	38	40	2	20
Otyrar, Ordabasy, Turkestan	40	30	7	23
Arys, Suzak	34	25	17	24
Tulkibas, Tole Bi, Sayram	12	14	23	51

and the transmission of the causative agent of piroplasmosis proceeds according to the transovarial type. Outbreaks of morbidity in animals mainly coincide with an attack on them, 2 sexually mature ticks *Hyalomma detritum*, *Hyalomma anatolicum*, sometimes *Hyalomma scupense*, in the spread of which meteorological, environmental, and biological factors play a role, which are peculiar in different areas.

Varieties of ticks *Hyalomma detritum* and *Hyalomma anatolicum* can develop autonomously in closed rooms for cattle, which explains the presence of stationary foci of the disease in some localities. At all stages of the development of the disease, adult ticks of these varieties are parasitised only on large domestic animals, which causes a constant circulation of theileria.

Notably, the predominant species collected were *H. detritum* (34.8%), *B. calcaratus* (30.8%), *H. anatolicum* (28.4%). Then *H. asiaticum*, *H. plumbeum* follow in descending order. The remaining species were found in small amounts from 0.05 to 0.08% of the total collection. Of the 5 species of the genus *Hyalomma* – *H. asiaticum*, *H. plumbeum*, *H. punctata*, *H. detritum*, *H. anatolicum*, and the genus *Boopillus* – *B. calcaratus* – are the main carriers of blood-borne diseases of cattle in the region. *H. detritum* and *H. anatolicum* ticks can develop on premises and livestock bases, which explains the existence of stationary foci of the disease in cities.

In this context, the form of the course of the disease in different individuals of cattle may have significant differences, depending on several factors, among which the most important are: the age of the animals, their physiological state, and the current state of immunity. The pathogenicity and virulence of *Theileria annulata* are also important in each case. The most severe course of theileriosis is observed in summer and to a lesser extent – in the autumn and spring periods. In addition, in matters of weakening or strengthening the pathogenicity of theileria, the ambient temperature is of great importance, as one of the main factors in changing the reactivity of the organism of animal individuals.

The study of the timing of the parasitisation of ticks on animals in various geographical zones allowed for carrying out therapeutic and preventive measures more rationally. In turn, the rational implementation of therapeutic and preventive measures contributes to maintaining a stable level of the number of cattle, also ensures the preservation of the health of domestic animals, and prevents the occurrence and subsequent spread of various diseases on farms that threaten the safety of cattle.

DISCUSSION

The study of the degree of influence of parasites on cattle from the standpoint of ensuring the safety of individuals is given increased attention in the specialised literature, which publishes research data on various

features of the spread of parasites in rural farms of various countries. At the same time, the issues of hypodermatosis in cattle have rather underinvestigated in the context of identifying all aspects of parasitic-host relations (Mohmad et al. 2022). To date, qualitative decoding of the interaction of pathogens of parasitic diseases with the host can be successfully performed thanks to the practical use of the data of the conducted biochemical, haematological, and histomorphological studies (Shabdarbaeva et al. 2016).

The findings of numerous studies indicate that various issues related to the bioecological features of the development of pathogens of parasitic diseases of cattle, their spread, and the development of practical measures to prevent the spread of this problem are still poorly understood. Knowledge of the basic measures to combat parasitic diseases in cattle and the ability to apply these measures in practice would contribute to the creation of optimal conditions for an optimal combination of therapeutic and preventive measures aimed at combating the spread of parasites at agricultural facilities (Kuotsu et al. 2022). Drugs used to treat diseases in pets and prevent the recurrence of infectious diseases in them are selected in strict accordance with the age of the animal and its weight, and also the specific area of the use of drugs against certain groups of pathogens is important (Aziz et al. 2019). For example, in several Brazilian farms, to prevent the occurrence and development of dermatosis in cattle caused by gadfly bites, a 5% solution of the Russian drug Cyperil was applied, and the method of external spraying was used with a planned consumption of no more than two litres of the drug per animal during the day. The course of treatment ranged from seven to ten days, depending on the individual characteristics of the animal. In this context, animal treatments carried out at the early stages of the development of larvae introduced under the skin during the bites of flies and gadflies have shown the greatest practical effectiveness (Vieira et al. 2019).

The direct causative agent of bovine theileriosis was first discovered during studies of animal blood in Africa (Medjkane and Weitzman 2020). Cardinal differences in the signs of the course of this disease from typical piroplasmosis were found. Subsequently, numerous seasonal experiments conducted on cattle units demonstrated that there are special inclusions of plasma consistency in the blood of affected animals, which later became known as "plasma balls" or "garnet bodies" (Jaja et al. 2017). A significant danger of piroplasmidae for the agricultural sector is that the disease is observed in the spring-summer-autumn period, while the manifestation of this disease in cows leads to a decrease in the volume of dairy products, a decrease in fattening gains, and high mortality of animals with delays in the intervention of veterinarians (Olsen et al. 2019). Prevention of theileriosis involves significant material costs, which is not always possible for agricultural enterprises (Hayati et al. 2020).

This explains the sometimes unjustifiably high mortality from this disease, which, with its timely detection and preventive measures, does not seem so dangerous for domestic cattle. A recent study by G. Rana (2018) has confirmed the fact of the relative abundance of pathogens of this disease, which is partly explained by the difficulties with their classification and variability conditioned by the combination of many factors that determine both the nature of the course of the disease and the peculiarity of infection of animals of specific groups.

The tangible economic effect caused by this disease determines the need for the development and practical implementation of comprehensive measures aimed at curbing losses in animal husbandry caused by this disease, and the prevention of its subsequent occurrence. It is noted that mortality in domestic animals is mainly common among imported individuals most susceptible to the effects of the causative agent of this disease, in addition, the deterioration of the epidemiological situation associated with this disease often leads to a significant decrease in the productivity of domestic cattle (Chaparro et al. 2016). Theileriosis has many specific signs, and changes of a pathoanatomical nature, which give grounds to distinguish it from other haemosporidian infections of animals (Chaparro-Gutiérrez et al. 2020). There are various varieties of this disease, manifested in different individuals and different geographical regions. The main form of the course of this disease is acute, which is associated with a sharp deterioration in metabolism, general poisoning of the animal's body, and significant functional disorders that almost completely negate the reaction of the body of animals affected by the causative agent of the disease to the introduction of chemotherapeutic drugs into their body (Tahir et al. 2020). With untimely or poorly performed treatment, the disease most often leads to the death of animals.

Often, the lack of effective methods of treating theileriosis becomes the main cause of problems with finding solutions to prevent the occurrence and spread of the disease in agriculture in a single state (Tarekegh et al. 2021). Achieving optimal results in the treatment of this disease becomes possible when finding the means necessary to effectively solve the problem of alleviating the course of the disease among cattle and improving existing therapeutic techniques aimed at weakening the action of the causative agent of the disease through the use of modern chemotherapy. Combined methods of treatment have gained wide popularity, aimed at using many drugs in various combinations for the treatment of sick animals, the effect of which is directed at different groups of animals at different stages of the disease.

Practical seasonal studies have shown that theilericide is an effective means of treating theileriosis in cattle. Two intramuscular injections at the rate of one millilitre per 20 kg of pet weight are enough to obtain the strongest therapeutic effect. Notably, the interval between such injections should be no more than two days, in addition, it is necessary to combine the mentioned method of treatment with the use of other means, both pathogenetic and symptomatic. The development of methods of chemotherapy and chemoprophylaxis of piroplasmosis should be carried out taking into account the results of a preliminary study of the condition of sick animals and the

environmental characteristics of the conditions in which they were kept. This implies a careful selection of drugs, considering the age of the diseased animals, and a number of their characteristics, including the current state of the organism of the diseased animal (Hayati et al. 2020).

Numerous studies indicate that the best results were obtained during the complex treatment of bovine theileriosis, combining some effective therapeutic techniques (Auapa et al. 2021; Ringo et al. 2018). However, in all practically investigated situations, the treatment was prolonged, required numerous labour and material resources, and was associated with great risk to the health and life of the animal. A good therapeutic effect is achieved with timely veterinary care, combined with compliance with mandatory recommendations for the care of a sick animal, including timely feeding. In addition, the correctness and timeliness of the use of specific drugs, both symptomatic and pathogenetic, also have an impact on the effectiveness of the treatment. It may also be justified to prescribe individual medications to sick animals, dictated by the individual characteristics of the course of diseases in each specific case (Deksne et al. 2020). Symptomatic therapy of theileriosis helps to improve the overall therapeutic effect and achieve optimal treatment results, provided that the occurrence of side effects is prevented (Caminade et al. 2019). Further studies of various aspects of the dynamics of the spread, seasonality, and degree of infection with bovine theileriosis will contribute to the identification of the latest effective methods of disease therapy and prevention of its occurrence in livestock farms.

Conclusion

The study of the epizootic situation of bovine theileriosis in the Turkestan Region in the south of Kazakhstan, and the timing of parasitisation of ticks on animals in various geographical zones, allows carrying out therapeutic and preventive measures more rationally. *Hyalomma detritum* and *Hyalomma anatolicum* theileriosis is more acute and severe in the summer and is much easier in early spring and autumn. This necessitates the development and practical implementation of a set of preventive measures aimed at strengthening the immune protection of cattle directly in the spring, summer, and autumn months, to prevent infection with the pathogen of the disease in question and eliminate the prerequisites for the subsequent development of the disease already when it occurs.

As the degree of infection of the cattle population with the causative agent of this disease decreases, the percentage of deaths will decrease, which is an essential prerequisite for the preservation of the cattle population as a whole. In this context, special attention should be paid to the timely provision of veterinary care to infected animals, which implies the obligation and regularity of medical and preventive measures in all livestock farms of the Turkestan Region without exception. The qualitative implementation of all mandatory measures to consider the dynamics of the spread of theileriosis and the timeliness of its prevention and treatment would contribute to the preservation of cattle and a significant reduction in mortality from this disease in the Turkestan Region in particular and in the livestock farms of the country as a whole.

Conflict of Interest

There are no conflicts of interest.

Authors' Contribution

All authors have made remarkable contribution to this work.

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