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Ixodes ticks of Kostanay region: biodiversity and distribution

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Abstract

Background and Aim. All over the world ixodes ticks are known as carriers and keepers of causative agents of some dangerous diseases in animals and humans. A large role in the research is given to the circulation of ixodes ticks. The fauna of ixodes ticks is a group of parasitic arthropods which has not been researched well enough in the northern region of Kazakhstan. The goal of the research was to identify ixodes ticks within the area of Kostanai region. The objectives were to determine species composition and their geographical distribution in Kostanai region.

Materials and Methods. The research work was carried out on the territory of Kostanay region. Ixodic ticks were collected using a flag. The determination of the type of ticks was carried out using light microscopy based on morpho-anatomical features

Results. In the course of research ticks of various species were found, such as *Dermacentor, Hyalomma* and *Rhipicephalus.* Two species of ticks are widespread in Kostanay region: *D. reticulatus Fabricius* -51.3% and *D. marginatus Sulzer* - 46.5%, single specimens were found as well, *D. niveus Neumann* – 0.9%, *H. scupence Sulzer*– 0.9% and *Rh. schulzei* Olenev - 0.4%. They were found in the southern area of the region.

Key words: Ixodes ticks; Kostanai region.

Introduction

Ixodes ticks are reservoirs and carriers of viral, bacterial, parasitical and fungous diseases. Their diverse epidemiological roles are influenced by various factors like environment and species composition and how well every species has been studied. Some of the diseases that can be transmitted by these ticks include tick-borne encephalitis, tick-borne borreliosis, hemorrhagic fever, ehrlichiosis, anaplasmosis, rickettsiosis, tularemia, and babesiosis. They are of significant concern to both medical and veterinary fields [1]. It is possible for a single tick to carry multiple pathogens from different groups [2, 3, 4].

The expansion of the ranges of different types of ticks, capable of spreading pathogens of infectious diseases in humans, farm animals and domestic animals, is registered today in many regions of the world, and it is a threatening phenomenon. The research of newly emerging natural foci of these diseases requires a comprehensive scientific approach. It is equally important for healthcare systems, sanitary and epidemiological control services in different countries to pay close attention to this issue.

Out of big diversity there are six genera of ixodes ticks that can be found in Kazakhstan, they are *Dermacentor spp, Ixodes spp, Rhipicephalus spp, Haemaphisalis spp, Hyalomma spp,* and *Boophilus spp* [5, 6]. Although ixodes ticks have been well-studied in the central, southern, southeastern, and western regions of Kazakhstan, the fauna of ixodes ticks in northern Kostanay region has yet to be fully explored.

In this connection, the aim of the work is to determine the species composition of ixodes ticks and their geographical distribution within Kostanay region.

Materials and methods

Ixodes ticks collected from various landscapes and climatic zones in three cities and eight areas of Kostanay region were used as a research material. The process of picking ixodes ticks took place between 2017 and 2019. It was done during the period of their activity, which typically spans from April to November, starting with the period of snow melting. Depending on vegetation biomass on the areas being surveyed, different methods were used to pick ticks; tick flags were used on meadows and in forest areas with high grass, while tick drags were used in steppes and low-grassy meadows (Figure 1). Ticks picked from different areas were placed separately in test tubes to ensure accurate identification and analysis.

Figure 1 – Picking ticks

Binocular microscope MBS-10 (Lytkarinsky Optical Glass Factory, c. Lytkarino, Russia) and determinants of Kerbebaeva E.I. (1998), Kapustina V.F. and Yakimenko V.V. (2013) were used to identify the species of ticks. Species validation of ixodes ticks was done by experts at National University of Life and Environmental of Ukraine, Kiev. The ticks (n=1756) were identified to the species level using morphological keys and the life-cycle stage and sex were determined. Where tick identification based on morphology was uncertain, sequencing was used; if the species could still not be reliably identified, the tick was excluded from the study. This approach allowed for accurate identification of the species of ticks and mites, which is essential for further analysis of their potential impact on human and animal health in the region [7]. Molecular genetic studies were carried out in the laboratory of the Scientific Research Center of Applied Biotechnology, Kostanay city and «National Center of Biotechnology» SC of the Ministry of Education and Science of the Republic of Kazakhstan.

Results

The study was in 2017-2021. Of these, 1756 ticks were identified to species including 5 species of the Ixodidae, although 32 submitted ticks could not be analysed because of damage during collection or transport. Submitted ticks most were adults, with 67,1% adult females and 32.5% adult males. Juvenile ticks were 0.4% nymphs.

We were doing the research on the species identification of ixodes ticks, which were collected in various landscapes and climatic zones of Kostanay region.

Kostanay region covers the area of 196,000 km2 or approximately 8% of the total area of Kazakhstan. The region is quite vast, stretching 700 km from the north to the south and 300-400 km from the west to the east. The topography of the region is predominantly flat, the area borders with the West Siberian Lowland in the north, the Torgai Plateau in the south, the Trans-Ural Plateau in the west and the small hills of Saryarka in the south-west. Kostanay region borders with several other regions of Kazakhstan, including North Kazakhstan, Akmola, Aktobe, Karaganda and Ulytau, as well as with three regions of Russia - Kurgan, Chelyabinsk and Orenburg.

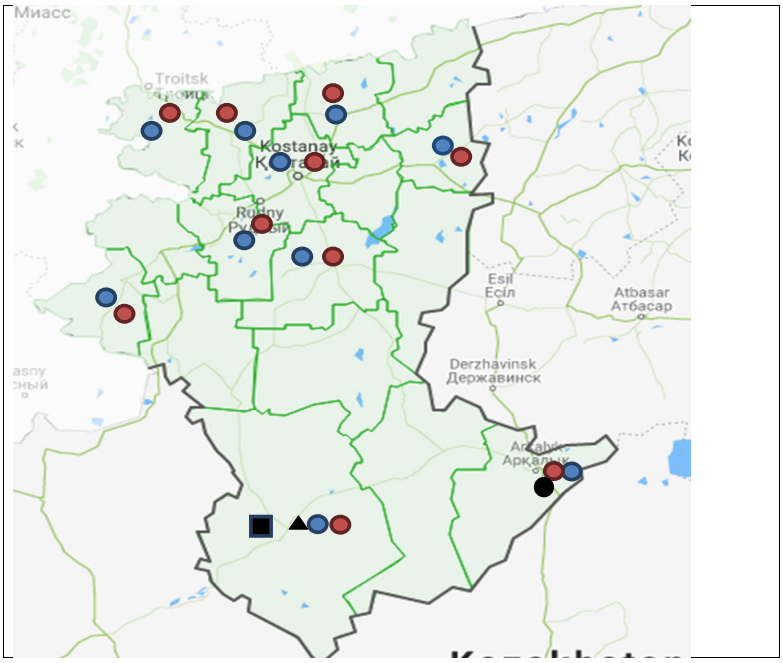
The areas where ticks were collected were: Kostanay, Fedorovsky, Karabalyksky, Auliekolsky, Sarykolsky, Mendykarinsky, Zhitikarinsky, Dzhangeldinsky areas and the cities of Kostanay, Rudnyi and Arkalyk.

The distribution of these ixodes ticks across the region varied and depended on the landscape and geographical characteristics of each area (Figure 2).

While doing the research of the ixodes tick fauna in Kostanay region, we identified 3 genera and 5 species of these ticks.

The data of the species composition of ixodes ticks within the area of Kostanay region are presented in Figures 3-7.

It can be seen that D. *reticulatus Fabricius* were 45% in 2017, 56.6% were picked in 2018, and 56.1%. were picked in 2019. In 2017, 52.8% of ticks D. *marginatus Sulzer* were picked, 42% and 41.3% were picked in 2018 and 2019 respectively. Also, in the southern areas some single specimens of D. *niveus Neumann* were found, 0.7% were picked in 2017, 0.5% were picked in 2018 and 1.4% were picked up in 2019. As for H. *scupence Shulzei* picks, in 2017 0.9% were picked, 0.5% - in 2018 and 1,2% - in 2019. As for *Rh. Schulzei Olenev*, 0.6% were found in 2017. 0.4% - in 2018 - (Figure 3).



- Kostanay region is marked with a black line - other areas are marked with green lines						
	●	*D.reticulatus*	▲	*H. scupence*	■	*Rh. schulzei*
	●	*D.marginatus*	●	*D. niveus*		

Figure 2 – The map of geographical distribution of ixodes ticks in Kostanay region.

Thus, in Kostanay region there are three genera: Dermacentor, Hyalomma and, Rhipicephalus. At the same time, the genus Dermacentor is represented by three species: *D. reticulatus, D. marginatus,* and *D. niveus*. Of these, the most common species in the region are ticks of *D. reticulatus* (51.3%) and *D. marginatus* (46.5%). The ticks of D. niveus were 0.9%, the ticks of *H. scupence* were 0.9% and *Rh. Schulzei* were 0.4%.

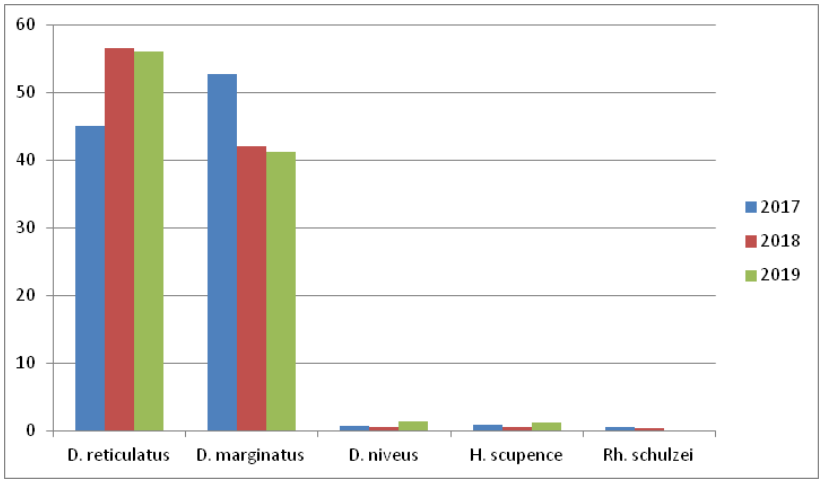


Figure 3 – Species composition of ixodes ticks in Kostanay region from 2017 to 2019

In ticks of the genus *Dermacentor*, there is a scutum on the dorsal side of the body with a characteristic enamel-like pigment (marble pattern). The color of the cuticle is dark brown. The posterior end of the body has 9-11 festoons (Figure 4). The peritremes are oval, with a dorsal process.

Dermacentor reticulatus has a hexagonal gnathosome base (with lateral projections) There is a thorn pointing backwards on the dorsal side of the 2nd segment of the palpi. The palps are angular, the outlines of the proboscis together with the palps are hexagonal (Figure 4, the spike is marked with a red arrow). In males, the scutum covers the entire dorsal part of the body (Figure 5).

Dermacentor marginatus there is no thorn on the dorsal side of the 2nd segment of the palpi. The palps are smooth, the outlines of the proboscis together with the palps are quadrangular (rectangle). The color of the cuticle of a hungry individual is dark brown. The dorsal process of the peritreme is well developed, has a chitinous thickening of the lateral margin (Figures 6 and 7).

Dermacentor niveus (Figures 8) the dorsal process of the peritreme is well developed (Figures 9), without thickening on the lateral margin.

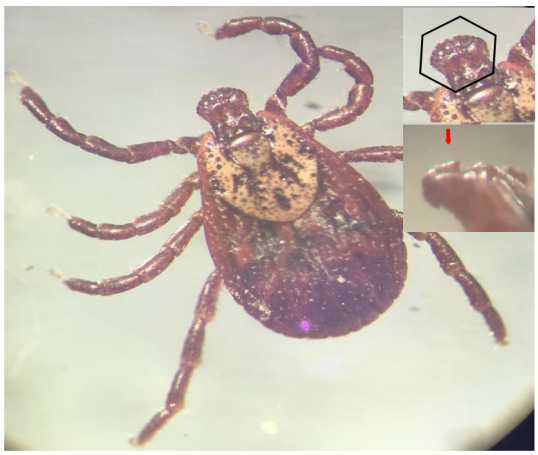


Figure 4 – *D.reticulatus* Female

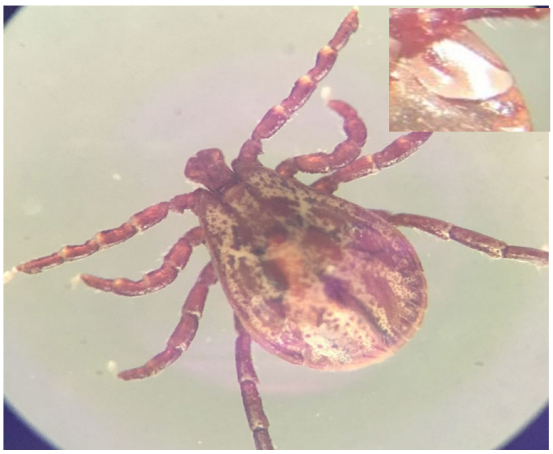


Figure 5 – *D.reticulatus* Male

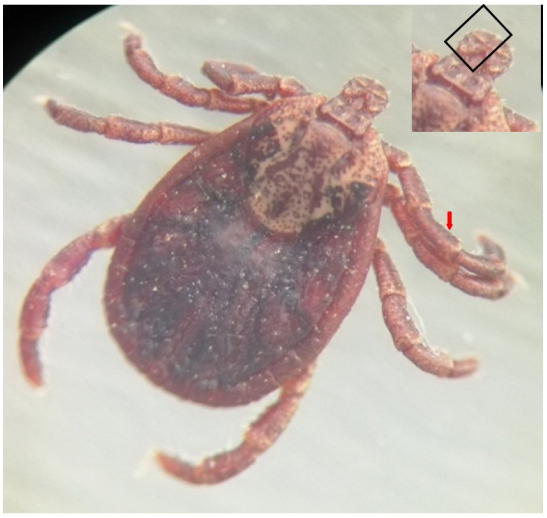


Figure 6 – *D. marginatus* Female

Figure 7 – *D. marginatus* Male

Figure 8 – *D. niveus* Female Dorsal side

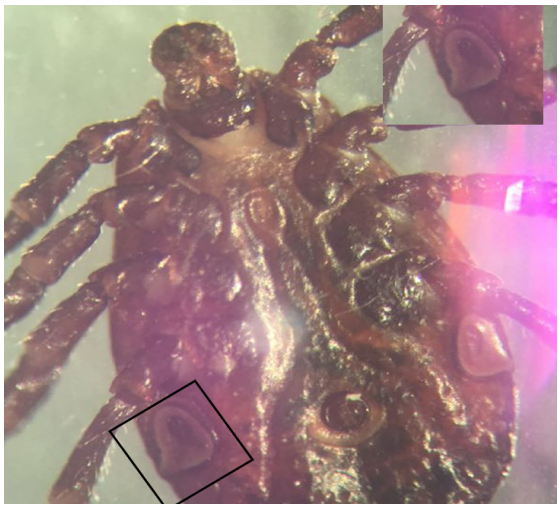


Figure 9 – *D. niveus* Female Ventral side

Since ticks of the species *D. reticulatus* (Figure 10) are widely spread in moderately humid and moderately dry climates, they are common in the areas of birch and pine forests, including steppe zones, i.e. Karabalyk area (12.8%), Fedorovsky area (11.1%), Mendykarinsky area (8.3%), as well as in the cities of Kostanay (31.6%) and Rudny (8.2%).

The species of *D. marginatus* (Figure 11) ticks were found all over, they were noticed in Kostanay area - 10.9% and in Auliekol area - 10%, and in the city of Kostanay - 15.5%, but they predominated in more southern arid areas of the steppe and semi-steppe, i.e., in Zhitikarinsky area -24.5 %. As well as, 8.2% of ticks were picked in Dzhangeldinsky area, and 9.1%. were picked in the city of Arkalyk.

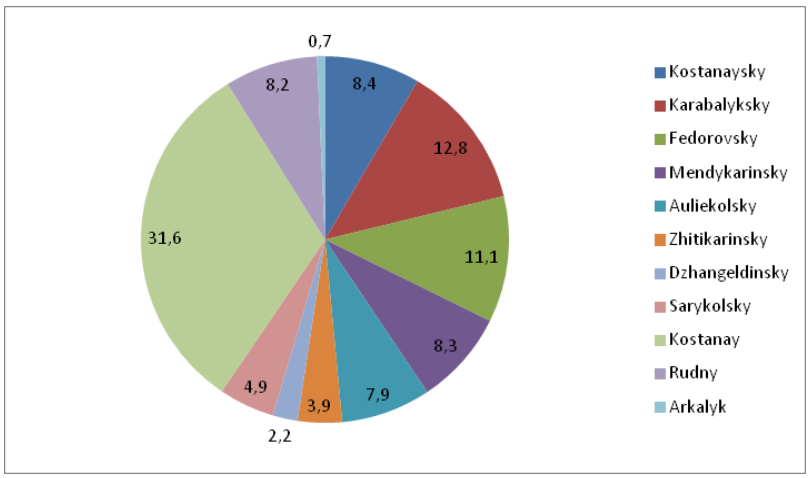


Figure 10 – Distribution of *D.reticulatus* ticks within Kostanay region

Rare species of ixodes ticks were identified in this natural area: the species of *D. niveus* were picked in the city of Arkalyk - 0.9%, and the species of *H. scupenceand* and *Rh. schulzei* were found in Dzhangeldinsky area - 0.9% and 0.4%, respectively.

Various species of ixodes ticks were found in Dzhangeldinsky area (Figure 12) and in the city of Arkalyk (Figure 13).

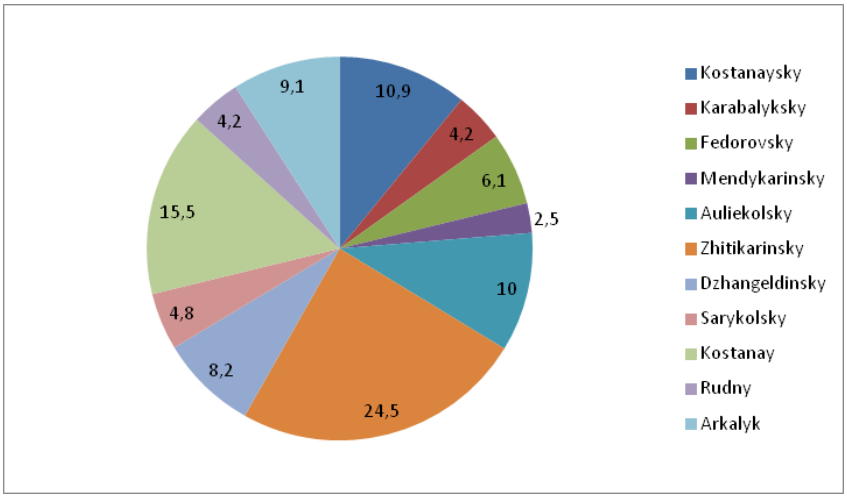


Figure 11 – Distribution of *D.marginatus* ticks within Kostanay region

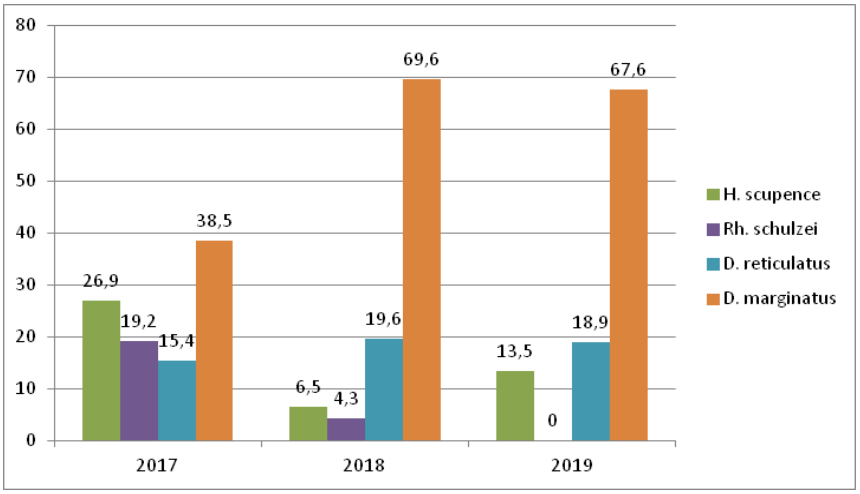


Figure 12 – Ixodes ticks of Dzhangeldinsky area

As can be seen from Figure 12, in the Dzhangeldinsky district, one species of ticks, *D. marginatus,* predominated within all years; twice as many of them were picked in 2018 and 2019 than in 2017.

In the city of Arkalyk the species of tick *D. niveus* were found, and they were not found anywhere else in the region.

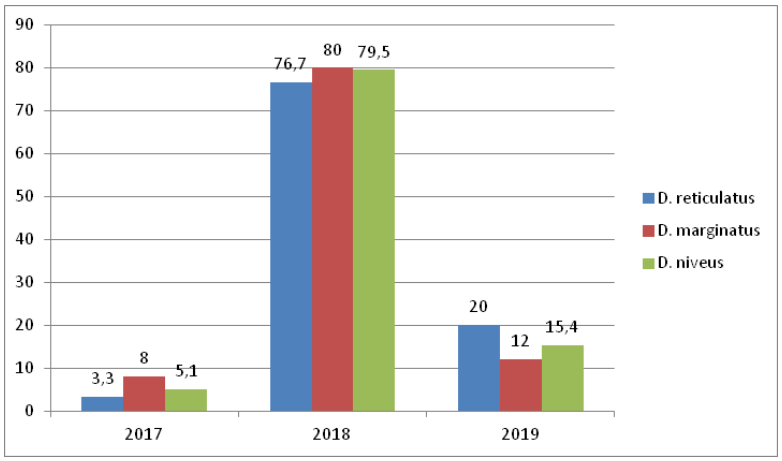


Figure 13 – Species diversity of ixodes ticks in Arkalyk

A lot of ticks were found in pasture areas where farm animals graze.

According to the results of our research, it was discovered that the density of ixodes ticks within the city was slightly lower than in the suburbs, the possible reasons can be the sparse vegetation in the city, mowing of lawns and a small number of hosts of pre-imaginal phases.

Discussion

Ixodes ticks exist all over the globe; one of the species, Ixodesuriae, lives even in the Arctic and the Antarctic [8]. Many studies have been conducted and it has been proved that Ixodes ticks make a major contribution to the spread of infectious, bacterial, parasitic and other diseases. To clarify the causes and conditions for the existence of a natural focus of any vector-borne disease it is essential to know the species composition and environment of the main sources and vectors of the pathogens according to the classification of E.N. Pavlovsky. (1964), [9]. Human influence on the environment has caused the transformation of nature and climate that accordingly has led to the changes in the habitats of ixodes ticks [10]. A comprehensive study of the family of Ixodidae ticks is of scientific and practical importance.

Of the 50 species of ixodofauna in Kazakhstan, there are 22 species in the west of the Republic of Kazakhstan. Five genera of ixodes ticks: *Ixodes, Haemophysalis, Dermacentor, Rhipicephalus, Hyalomma* were found in West-Kazakhstan part of the country. Four genera of ixodes ticks: I*xodes, Haemophysalis, Dermacentor, Rhipicephalus* and 12 species were identified in central Kazakhstan. A greater species diversity of ixodes ticks - *D. reticulatus* and *D. marginatus, D. niveus* (0.9%), *H. scupence* (0.9%) and *Rh. Schulzei* (0.4%) was discovered in Kostanay region in the south-western area, on the borderline of Aktobe and Karaganda areas. The quantity the ticks found was not large, it is the most likely ixodids inhabit and they are introduced from the neighboring southwestern areas.

In the border zones with the Russian Federation in the northern part of Kostanay region, species diversity is not significant and it is represented by only two species, which were found everywhere in the region, they were *D. reticulatus* and *D. marginatus.* It is worth noting that two species of ixodes ticks were identified in Chelyabinsk region, they were *D. reticulatus* and *I. persulcatus* [11].

In general, the climate in Kazakhstan is sharply continental, but when moving to the southern part of the country it becomes milder - subtropical. And unlike in the northern regions where the winter is long and harsh, in the southern areas the winter is shorter and the summer is hot and long. Due to the climatic conditions in the south of Kazakhstan, 35 species of blood-sucking ticks have been registered, 23 species are carriers of 18 species of pathogens of piroplasmosis. In general, large areas with dense herbaceous vegetation, an abundance of hosts for ixodes ticks in the Republic of Kazakhstan will contribute to the spread of vector-borne diseases of animals and humans.

Conclusion

Having completed the research on ixodes ticks in Kostanay region, it has been identified that there are five species of ixodes mites from three genera of *Dermacentor, Hyaloma*, and *Rhipicephalus*. The most numerous genus was *Dermacentor,* with 901 specimens of *D. reticulatus*. The species of *D. marginatus* were high in numbers and were picked on dogs and found all over the area. In the spring and autumn periods their number can reach 100%. The next species *D. marginatus* were found all over the place and 818 specimens in number. It is essential to mention that the species of ixodes ticks *D. niveus, H. scupense*, and *Rh. schulze*i were found in the smallest numbers in the southern area of Kostanay region.

Authors' Contributions

A.Zh. and R.R. conceived and planned the research. A.Zh. and R.R. carried out the experiments. A.Zh., A.Sh., Z.A. and Zh.A contributed to sample preparation. A.Zh., R.R., K.S. and A.Sh., contributed to the interpretation of the results. A.Zh. took the lead in writing the manuscript. R.R. corrected the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

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