

Distribution characteristics of ixodid ticks of the genus *Hyalomma* Koch, 1844 (Acari, Ixodidae) in the south of Kazakhstan

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Abstract

Ticks of the genus *Hyalomma* are widespread in the arid territories of Western and Central Asia and are known as one of the main vectors of the Crimean-Congo hemorrhagic fever pathogen. Several species of this genus live in the south of Kazakhstan and their number and distribution are heterogeneous. 100,539 specimen ticks of the genus *Hyalomma* collected from the soil surface, vegetation, rodent burrows, premises for keeping livestock, wild and domestic animals in settlements and their environs in Kyzylorda, Turkestan and Zhambyl regions were identified by morphological characteristics. There were studied 17841 specimens of ticks from the collection fund of the Republican State Enterprise "Institute of Zoology" of the Ministry of Education and Science of the Republic of Kazakhstan and the Republican State Enterprise "National Research Center for Especially Dangerous Infections named after M. Aikimbaev" MH RK. From the collected and studied ticks, 5 species were identified – *Hyalomma asiaticum* (36811 specimens), *H. scupense* (40204 specimens), *H. anatolicum* (22245 specimens), *H. turanicum* (1278 specimens), *H. rufipes* (1 specimens). In the south of Kazakhstan, 5 species of ticks of the genus *Hyalomma* were found. Certain biotopic confinement is noted in some species. The most numerous and widespread species *H. asiaticum* is found everywhere in the sandy deserts of the south of Kazakhstan, but is not found in the foothill and mountainous regions. *H. scupense* and *H. anatolicum* have adapted to living in settlements and their surroundings, located along the floodplains of large rivers and their tributaries. The distribution of *H. turanicum* in the south of Kazakhstan is limited within the foothills of

the Western Tien Shan. *H. rufipes* not typical for the fauna of Kazakhstan and is most likely introduced into the territory with migratory animals.

Keywords: ixodid ticks, *Hyalomma*, disease, Western Asia, Central Asia, Crimean-Congo hemorrhagic fever pathogen.

Introduction :

Ticks are vectors of many diseases. Through bites, bloodsuckers can transmit bacterial infections (tick-borne borreliosis (Lyme disease), recurrent fever, tularemia and babesiosis), rickettsial infections (spotted fevers, Q-fever, ehrlichiosis and anaplasmosis), viral diseases (tick-borne encephalitis, colitis Congo hemorrhagic fever, etc. It is observed by following researchers Marquez F.J., Constan M.C. (1990), Ermekov G.G., Matzhanova A.M., Bodykov M.Z. et al. (2011), BekenovZh.E., Nurmagambetova L.B., Dzhanbauova R.M. et al. (2012), Egemberdieva R.A., Ospanova A.M., Toksanbaeva K.N. et al. (2013), Kalmakova M.A., Matzhanova A.M., Iskakov B.G. (2013), Fuente J., Estrada-Peña A., Cabezas-Cruz A., Brey R. (2015), Atshabar B.B., Burdelov L.A., Izbanova U.A. et al. (2015), Zlobin V.I., Rudakov N.V., Malov I.V. (2015), Kalmakova M.A., Matzhanova A.M., Sayakova Z.Z. et al. (2016), BekenovZh.E., Nurmagambetova L.B., Sattigulov M.K., SarsenbaevaSh.T. (2016), Liberatoa de C., Frontosoa R. Maglianoa A. et al. (2018), Spengler J.R., Bergeron E. Y., Spiropoulou C.F. (2019), Rudakov N.V., Rudakova S.A. (2019), Ghafar A., Cabezas Cruz A., Galon C. et al. (2020) and Abdullah D.A., Viet L.N., Mohamed S.A. et al. (2020).

In Kazakhstan, much attention is paid to the study of transmissible zoonotic infections. Unfortunately, not enough attention is paid to the study of the fauna and the distribution of these arthropod vectors in the republic. Since the middle of the last century, deep fundamental research of ixodids in Kazakhstan has been reduced to almost zero. Of particular interest for study is the southern region endemic in the Crimea-Congo hemorrhagic fever. There is information about the finding of causative agents of this disease in ticks (Ermekov, Matzhanov, Bodykov et al., 2011; Kalmakova, Matzhanova & Iskakov, 2013; Kalmakova, Matzhanova, Savakova et al., 2016). Since information about the registration of tick-borne infections in the south of the republic is published annually in the literature, in this connection, special attention should be paid to the study of the ixodid fauna, distribution, abundance and other aspects. In the south of Kazakhstan, ticks of the genus *Hyalomma* Koch, 1844 are one of the main vectors of the Crimean-Congo hemorrhagic fever (Nurmakhanov, Sansyzbaev, Daniyarova et al., 2017). Ticks of the genus *Hyalomma* are the most numerous and widespread among ticks of other species living in the south of Kazakhstan. Ticks of this genus are very flexible and have a high adaptive capacity. These ticks are better adapted to living on the soil surface in hot and dry climates than other species and are active throughout the warm season. In settlements in livestock housing, some species of the genus can be active throughout the year. The preimaginal phases of ticks of this genus can feed on the blood of not only warm-blooded mammals, but also reptiles and birds. During seasonal intercontinental migrations, birds can bring in larvae and nymphs, which can attach to the host's body for a long time - up to 26 days (Liberatoa, Frontosoa, Maglianoa, 2018). Currently, the world fauna includes 27 species of the genus *Hyalomma* (Alberto, Guglielone, Robbins et al., 2010), of which 8 species live in Kazakhstan. We found 5 species of ticks of this genus in the south of the republic.

Materials and Methods :

The material for the work was 100539 specimens of ticks of the genus *Hyalomma*, collected by us in 2011-2020 on the territory of Zhambyl (8964 specimens), Turkestan (86321 specimens) and Kyzylorda

(5254 specimens) regions (Table 1). Also, 9292 specimens of ixodid ticks of this genus from the collections of the Zooparasitological Museum of the National Science Center especially dangerous infections named after M. Aikimbaeva for 1944-2020 and 919 specimens ticks from the Museum of the Institute of Zoology of the Ministry of Education and Science of the Republic of Kazakhstan for 1947-1956. Adult ticks with a pasture type of parasitism were collected from the soil surface and vegetation using a cloth flag. Ticks were removed from domestic animals using tweezers. Species with nesting-burrowing parasitism were obtained from rodent burrows. The collected material was immediately placed in a 70% solution of rectified alcohol for fixation and marked with the number, date, place of collection (coordinates according to the GPS navigator) and the animal from which the ticks or biotope data were collected. The collected ticks were taken to the laboratory for further research. The identification of ticks species was carried out using a stereoscopic binocular microscope by morphological features using keys (Apanaskevich, 2004).

Table 1. Species and number of ixodid ticks of the genus *Hyalomma* caught and examined in the south of Kazakhstan.

Species of ticks	Number of collected ticks by region, specimens			In total, ticks were collected, specimens
	Kyzylorda Region	Turkestan region	Jambyl Region	
<i>Hyalomma anatolicum</i>	1443	20737	65	22245
<i>Hyalomma asiaticum</i>	1589	26857	8365	36811
<i>Hyalomma rufipes</i>	1	-	-	1
<i>Hyalomma scupense</i>	2142	37562	500	40204
<i>Hyalomma turanicum</i>	79	1165	34	1278
Total:	5254	86321	8964	100539

Results :

As a result of our studies, 5 species of ixodid ticks of the genus *Hyalomma* were identified: *H. asiaticum*, *H. scupense*, *H. anatolicum*, *H. turanicum*, and *H. rufipes*. *H. asiaticum* Schulze et Schlottke is known in Kazakhstan and the republics of Central Asia as a vector of a large group of arboviruses: Crimean-Congo hemorrhagic fever (CCHF), Sverdlovsk Valley Fever (LSDF), Wad-Medani, Karshi, tick-borne encephalitis (TBE), Isfahan, Tamikhote-Alin, Sinbis, West Nile fever (WNF), Chikungunya, as well as theileriosis, rickettsia - the causative agents of Q fever and tick-borne typhus. In Kazakhstan and China, *Francisella tularensis* was isolated from ticks (Ermekeov, Matzhanova, Bodykov et al., 2011; Kalmkova, Matzhanova, Iskakov, 2013; Liberatoa, Frontosoa, Maglianoa et al., 2018; Spengler, Bergeron & Spiropoulou, 2019; Nurmakhanov, Sansyzbaev, Daniyarova et al., 2017; Kulemin, Shokputov, Tazhekov et al., 2011; Leblebicioglu, Eroglu, Ercivas-Yavuz et al., 2014; Aikimbaev, 1982; Shermatov,

Abdugopurov&Baynazarov, 2017; Guidance on Virology, 2013). Found by us in masse in the Aral, Kazalynsky, Karmakshynsky, Zhalagashsky, Syrdariinsky, Shielsinsky, and Zhanakorgan districts of the Kyzylorda region, Sozak, Otyrar, Aryss, Shardara, Turkestan regions, Sarysussky, Talasky, Moyuramsky regions, which are located in the Talas, Zhalyn region the zone of sandy deserts (Aral Karakum, Aryskum, Kyzylkum, Betpakdala, Moyinkum). Rare specimens were found in atypical habitats in the Ordabasy, Saryagash, Sairam and Maktaaral districts of the Turkestan region, where they were probably brought with cattle from other districts (Kulemin, Rapoport, Vasilenko et al., 2020). Adult females and males were found on the soil surface, on cattle and small ruminants, camels and horses from the last days of March to July (Rapoport, Kulemin, Melnichuk et al., 2017). A wide range of small animals of desert landscapes, on which *H. asiaticum* parasitizes, were noted, but most of the larvae and nymphs were collected from the great gerbil, which is the main host for the preimaginal phases, as well as from its burrows from April to June and in September-October (Kulemin, Kobeshova, Shokputov et al., 2016). Changes in the habitat of the great sand lance in Kazakhstan over the past decades, entails the expansion of the habitat of *H. asiaticum*(Atlas of the spread of especially dangerous infections in the Republic of Kazakhstan, 2012).

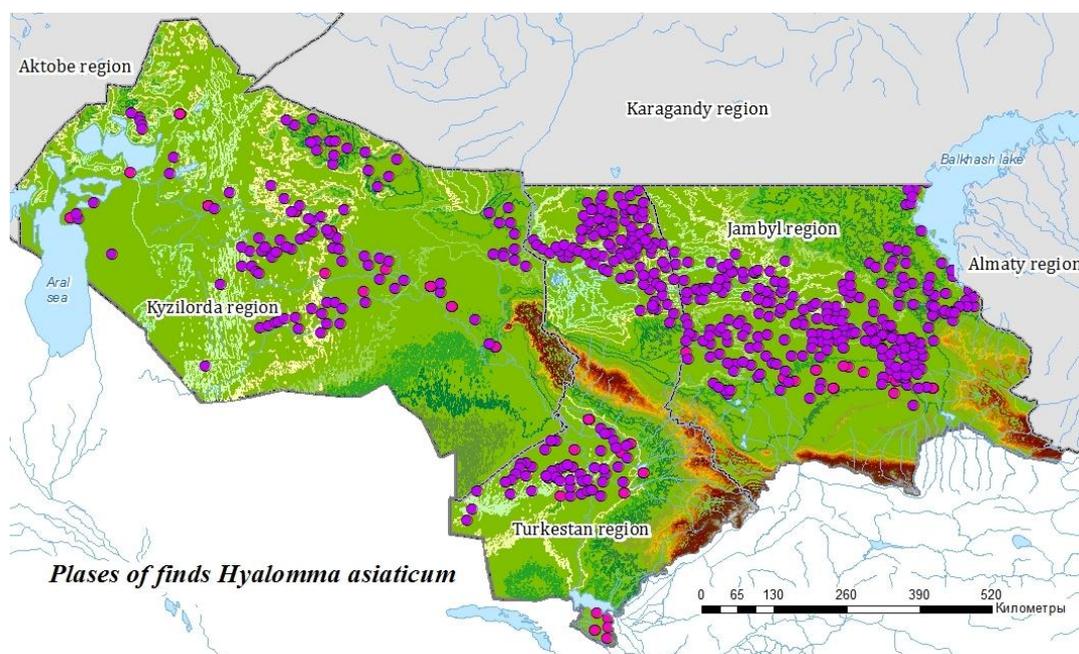


Figure 1. Locations of *Hyalommaasiaticum* finds.

Hyalommaanatolicum Koch, 1844 - a vector of the pathogens of theileriosis and gonderiosis of cattle, a possible vector of pathogens of sheep brucellosis, Borne's disease, piroplasmidosis, babesiosis, the causative agent of CCHF, West Nile fever, Kemerovo virus, Vad-Medani, Sindbis, Tamagdy, Karshi Alma-Arasan, Togoto and others in Uzbekistan, Tajikistan, Turkey, Iran, Pakistan, Saudi Arabia and Kazakhstan (Ermekov, Matzhanova, Bodykov et al., 2011; Kalmkova, Matzhanova, Iskakov, 2013; Liberatoa, Frontosoa, Maglianoa et al., 2018; Spengler, Bergeron & Spiropoulou, 2019; Nurmakhanov, Sansyzbaev, Daniyarova et al., 2017; Kulemin, Shokputov, Tazhekov et al., 2011; Leblebiciouglu, Eroglu, Ercivas-Yavuz et al., 2014; Aikimbaev, 1982; Shermatov, Abdugopurov&Baynazarov, 2017; Kulemin, Rapoport, Vasilenko et al., 2020; Shermatov, Baynazarov&Abdugopurov, 2017). Adults parasitize mainly on cattle (Asadollahi, Jalali, Alborzil et al, 2014).

We found ticks at all stages of development, mainly on cattle, less often found on small cattle, camels, horses, pigs, dogs, often ticks were found on pastures in the vicinity of settlements and in animal housing. Ticks were found in Kazalynsky, Syrdariinsky and Zhanakorgan districts of Kyzylorda oblast, Tulkibassky, Shardaransky, Saryagashsky, Maktaaralsky, Sozaksy, Baidibeksky, Sairam, Otyrarsky, Tolebiysky, Kazygurtsky, Arysky districts, Ordabasy oblasts, Zhytambasy regions (Figure 2). The highest abundance of *H. anatolicum* on farm animals is found in the area of irrigated agriculture along large rivers and in a semi-desert landscape (Kulemin, Rapoport, Vasilenko et al., 2020).

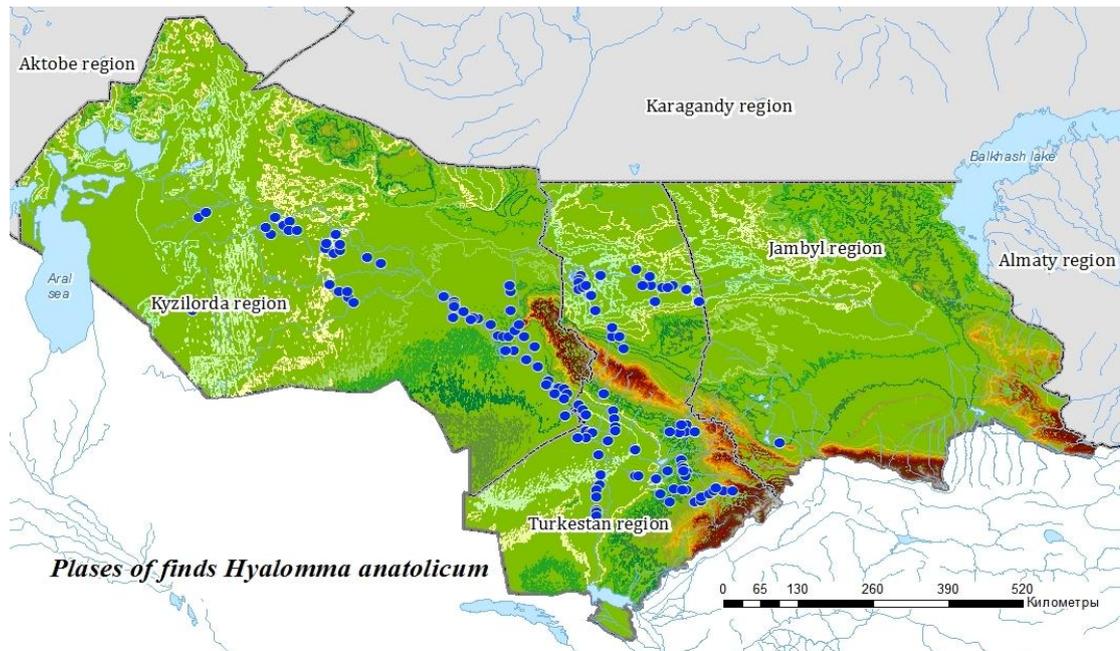


Figure 2. Locations of *Hyalommaanatolicum* finds.

Hyalommascupense Schulze, 1919 - a vector of theileria (*T. equi*, *T. annulata*), babesia (*B. caballi*), Burnet's rickettsia (*C. burnetii*), the causative agent of typhus (*R. sibirica*) and arbovirus infections (Crimean-Congo hemorrhagic viruses fever, West Nile fever, Bhanja) (Ermekov, Matzhanova, Bodykov et al., 2011; Kalmkova, Matzhanova, Isakov, 2013; Liberatoa, Frontosoa, Maglianoa et al., 2018; Spengler, Bergeron & Spiropoulou, 2019; Nurmakhanov, Sansyzbaev, Daniyarova et al., 2017; Kulemin, Shokputov, Tazhekov et al., 2011; Leblebicioglu, Eroglu, Ercivas-Yavuz et al., 2014; Aikimbaev, 1982; Shermatov, Abdugupurov & Baynazarov, 2017).

Ticks were collected in the Aral, Syrdari, Kazal, Zhanakorgan, Shielin districts of the Kyzylorda region. This species was found in all districts of the Turkestan region (Figure 3). Imagoes and nymphs are found in abundance on cattle and horses, less often on small cattle and camels. Larvae were found in open stations on tamarisk and chingil bushes. *H. scupense* ticks are found in various landscapes, where they are one of the dominant species among other species in collections, especially in the low-mountain steppe (Kulemin, Rapoport, Vasilenko et al., 2020).

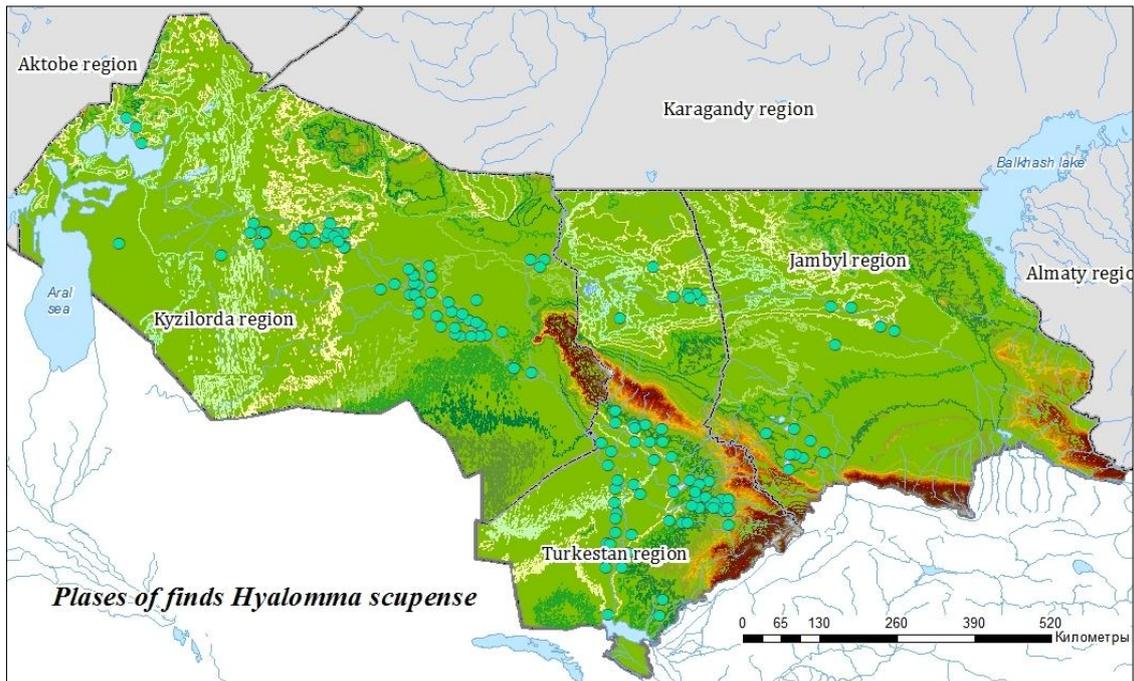


Figure 3. Locations of the *Hyalommascupense* finds:

Hyalommaturanicum Pomerantzev, 1946. In addition to the Crimean-Congo hemorrhagic fever virus (Bunyaviridae, Nairovirus), it is also a vector of West Nile fever, Bhanj, Tamdy, Dugbe, Matrukh, Jos, rickettsia *C. burnetii*, *R. sibirica* fever pathogens typhus, theileria *T. equi*, *T. annulata*, *T. mutans*, *T. buffeli*, *T. ovis* and babesia *B. canis*, *B. caballi* - the causative agents of theileriosis and babesiosis, the vector *Nuttalliaequi* - the causative agent of equine nuttalliosis, *Brucella melitensis* - the causative agent of brucellosis of sheep (Ermekov, Matzhanova, Bodykov et al., 2011; Kalmkova, Matzhanova, Isakov, 2013; Liberatoa, Frontosoa, Maglianoa et al., 2018; Spengler, Bergeron & Spiropoulou, 2019; Nurmakhanov, Sansyzbaev, Daniyarova et al., 2017; Kulemin, Shokputov, Tazhekov et al., 2011; Leblebicioglu, Eroglu, Ercivas-Yavuz et al., 2014; Aikimbaev, 1982; Shermatov, Abdugopurov & Baynazarov, 2017). The adults of this species of ticks parasitize on large domestic and wild ungulates mainly in mountainous and foothill zones. In Iran, it is the most widespread species among other ticks on sheep and goats (Razmi & Ramoon, 2012). We found ticks on cattle in the eastern part of the Zhanakorgan district of the Kyzylorda region (Figure 4). It is likely that the main habitat of this species in Kazakhstan is the foothill zone of the Western Tien Shan, which is confirmed by our findings in 2018 in the foothills of the ridge. Karatau. Based on our research, we can assume that the western part of the Karatau ridge limits the range of *H. turanicum* within the Zhanakorgan district of the Kyzylorda region. In the Turkistan region, it is rather rare, more often in a semi-desert and low-mountain-steppe landscape. The adults were removed from cattle and small ruminants (Kulemin, Rapoport, Vasilenko et al., 2020).

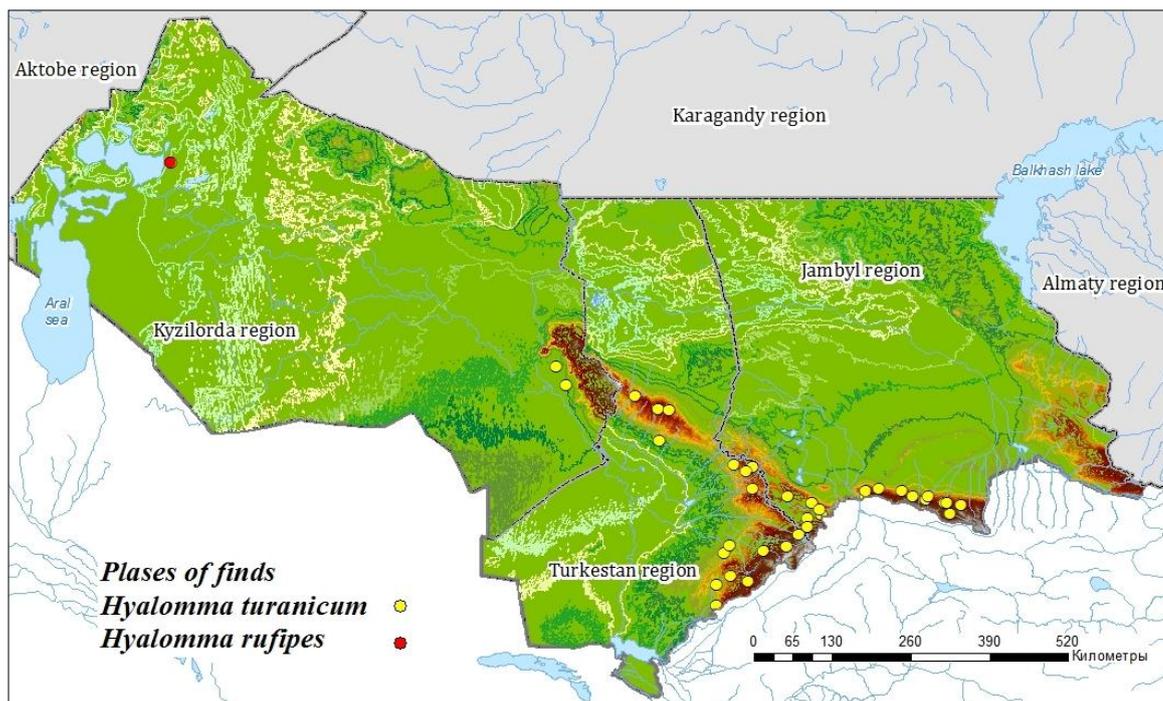


Figure 4 - Place of finds of *Hyalommaturanicum* and *Hyalommarufipes*

Hyalommarufipes Koch, 1844 *H. rufipes* was originally cited as a subspecies of *H. marginatum rufipes*. Judging by the latest publications, *H. rufipes* is isolated as an independent species (Albero, Guglienone, Robbins et al., 2010). Epidemiological and epizootic significance in Kazakhstan has not been studied. In England, rickettsia, the causative agent of spotted fever, was identified from a tick removed from a horse. In Africa, the CCHF and Bhanja viruses have been isolated from ticks (Guidance on Virology, 2013). Widely distributed on the African continent (Uilenberg, Estrada-Pena & Thal, 2013). In western Turkey, this species was found on cattle (Bakirci, Sarali, Aydin et al., 2011). In Europe, single specimens of this species of ticks, which are not autochthonous, were found, apparently by chance (Chitimia-Dobler, Schaper, Rieß et al., 2019; Hubalekl, Sedlacek, Estrada-Pena et al., 2020).

In Kazakhstan, the finding of the species was previously unknown. There is information about cases of introduction of the species in the nymph stage into European countries with migratory birds during their spring migration from African countries to nesting sites (Liberatoa de, Frontosoa, Maglianoa et al., 2018).

We studied a single specimen (♀) taken on June 26, 2019 from a camel in the Aral district of the Kyzylorda region (Figure 3). The specimen is kept in the Kazakh Scientific Center for Quarantine and Zoonotic Infections named after M. Aikimbaev.

Discussion :

The territory we surveyed is located east of the Aral Sea, mainly within the Turan lowland. The climate is sharply continental and extremely arid with long hot and dry summers and relatively warm, short and little snowy winters. Most of the territory is occupied by the deserts of the Karakum, Kyzylkum, Muynkum. The northern part is occupied by the Betpak-Dala desert, in the extreme south - irrigated lands. The largest rivers are the Syrdarya with tributaries and the Chu river, which flows in the north and is lost in the sands of Moyinkum. The southern part is limited by the western spurs of the Tien

Shan. A significant part of the territory is occupied by sandy deserts with typical vegetation; on the fixed sands wormwood-fescue, saltwort vegetation, the fauna of rodents, as well as predatory and ungulates, birds is diverse here. The main direction of agriculture is agriculture and animal husbandry. Wild and domestic animals are the main hosts for a wide variety of blood-sucking arthropods, including ixodid ticks. About 30 species of ixodid ticks, including ticks of the genus *Hyalomma*, are known to inhabit the study area.

Ticks of the genus *Hyalomma* are found almost everywhere in the south of Kazakhstan, with the exception of the highlands. Their range is occupied by desert, steppe and foothill areas. The distribution of species of ticks of the genus *Hyalomma* has its own characteristics. Thus, the pasture tick *Hyalomma asiaticum*, which lives mainly in sandy deserts, was encountered by us everywhere in all three regions, with the exception of the foothills of the western Tien Shan. The main hosts of the preimaginal phases are small mammals (rodents, insectivores), adults parasitize large mammals, including domestic animals, more often camels and cattle, and are also found on a long-eared hedgehog.

Hyalomma scupense and *Hyalomma anatolicum* were collected in large quantities in the vicinity of settlements, in premises for keeping livestock and on domestic animals, mainly on cattle and small ruminants. These species of ticks have adapted to living on domestic animals and passed from the pasture to the pasture-stall type of parasitism. With the development of private animal husbandry, the number of livestock in the population increased, which contributed to an increase in the habitats of *H. scupense* and *H. anatolicum* and the emergence of persistent, numerous village populations.

Ticks *Hyalomma turanicum* used to be rarely found in collections from cattle only in the Turkestan region, mainly in the foothills of the Karatau ridge. Since 2018, the species has also been recorded on the territory of the Kyzylorda region, in the southwestern part, where the western part of the ridge lies, which may indicate the expansion of the boundaries of the range of this species.

H. rufipes is not a species of the fauna of Kazakhstan. Since the immature developmental phases of this species feed on the blood of birds, but the East European and Indo-Asian migratory routes of migratory birds pass through the territory of the republic, therefore, single specimens can be introduced at a certain stage of development of these ticks (Atlas of the spread of especially dangerous infections in the Republic of Kazakhstan, 2012).

Conclusions :

In the south of Kazakhstan, 4 species of ticks of the genus *Hyalomma* constantly live, which form the basis of the fauna of ixodid ticks of the studied region. The most numerous and widespread species *H. asiaticum* lives almost everywhere in desert zones, with the exception of foothill and mountainous regions. *H. scupense* and *H. anatolicum* adapted at all stages of development to habitat on cattle and small ruminants in settlements and their surroundings. *H. turanicum* has a limited range in Kazakhstan. This is mainly the foothill part of the western Tien Shan. Previously, the species was found only in the foothill zone of the Turkestan region. Since 2018, *H. turanicum* has become a regular occurrence in the southwestern part of the Kyzylorda region, where the western end of the Karatau ridge is located. Based on our findings, we have reason to assume that the boundaries of the range of this species are expanding in the western direction, and the Karatau ridge in this case serves as an ecological channel for the movement of this species to the west. Thus, the northwestern border of the range of this

species is located within the foothill zone of the Karatau ridge. *H. rufipes* does not inhabit Kazakhstan and is likely to be introduced into its territory with migratory animals.

Ticks of the genus *Hyalomma* are the most important vectors and reservoirs of many dangerous and some not yet sufficiently studied pathogens of human and animal infections. Further research is needed on individual issues of distribution, ecology, and phenology of ticks in order to develop effective preventive measures against vector-borne diseases.

Research funding source:

The work was prepared as part of the implementation of the scientific and technical program "Development of scientific foundations of a unified system for the Republic of Kazakhstan for monitoring, diagnostics and microbial collection of pathogens of especially dangerous," returning ", newly emerging and imported infections" (Code of the program O.0819).

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