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Tick-born infections and invasions in the Republic of Belarus

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On the territory of the Republic of Belarus, the growth of infectious and invasive diseases of humans and animals, caused by ticks and insects, continues. The study of the ecological, logistic and phenological patterns of ontogenesis of ixodid ticks in different climatic zones of the Republic of Belarus, the development of various methods for monitoring and predicting the number, timing of the increase in the population and the increase in the activity of ixodids seems relevant. The purpose of the study was to analyze the features of the distribution, species composition and seasonality of the attack of ixodid ticks in different climatic zones of the Republic of Belarus over the past 5 years.

To determine the seasonal activity of ticks and the seasonality of a number of tick-borne infections and infestations among animals, both our own research on the collection of ticks, the selection and examination of blood (blood smears), and the collection of reporting data from veterinary clinics (private and public), data from regional veterinary stations, reporting Ministry of Health data for 2016–2020 to study the features of seasonal dynamics and climatic-geographical features of the distribution of both tick-carriers themselves and tick-borne infections and invasions among animals and the population. The data on the distribution, species composition and seasonality of the attack of ixodid ticks in different climatic zones of the Republic of Belarus are analyzed. A tendency is shown to change the season of tick activity and the seasonality of tick-borne infections and invasions towards their registration throughout the year (all seasons of the year). A change in the habitat of ticks and their wide distribution in the urban area were revealed. An increase in the number of registered cases of seasonal invasions and infections, both among the population and among domestic animals, has been established.

Key words: ixodid mites, tick infections, invasion, animals, population, the Republic of Belarus.

Problem statement and analysis of recent research. Infectious and invasive diseases of humans and animals caused by ticks and insects continue to grow on the territory of the Republic of Belarus nowadays. A special place is occupied by diseases whose pathogens are transmitted by ixodic ticks among them [1].

The value of ixodids as carriers of pathogens of natural focal diseases of animals and humans has been proven a long time ago. Moreover, many studies have shown the ability of ticks to transmit pathogenic protozoa, bacteria, viruses, and rickettsias to feeders [2–4].

Ixod mites damage the skin and fur as they parasitize animals; wounds are formed in places where the parasites are crowded, what leads to the

culling of up to 86% of the raw leather. As a result of long-term parasitization of hematophages, signs of anemia and emaciation are observed in cattle, meat and dairy productivity decreases by 12% and 18–40%, respectively [5–7].

Under the influence of environmental and socio-economic factors, the number of biotopes that are favorable for breeding ticks, the number and species composition of ixodids change. An unfavorable epizootic situation for piroplasmidosis persists in both small domestic and farm animals [8], and cases of human disease after a tick bite periodically increase.

The number and the activity period of ticks in natural habitats increasing in connection with climate change. The most important conditions for

the existence and development of ticks in forest biotopes are sparse stands, moderate moisture content of the soil and the ground horizon, developed grass cover and thick forest floor [9]. All these natural factors are fully realized on the territory of Belarus.

Nowadays, the quantity of domestic and imported acaricidal drugs has more than a hundred drugs, but all this does not restrain the spread of vector-borne diseases that are dangerous for both humans and animals, and does not reduce the number of parasites [10].

Ticks that cause pathological changes in animals belong to the Arthropoda type (arthropods), the Chelicerata subtype (chelicerata), the Arachnida class – arachnids, two orders – Parasitiformes Zachvatkin, 1947 – Parasitiformes and Acariformes Zachvatkin, 1947 – Acariformes ticks [11].

Ticks are the largest group in the class: currently, more than 48 thousand species of ticks have been described [12]. *Ixodes ricinus* and *Dermacentor reticulatus* ticks are of major epidemic importance in the Republic of Belarus. Representatives of these families are characterized by an extremely wide range of "feeders" (animals-humans) and the greatest degree of aggressiveness. According to various studies [13, 14], up to 50% of ticks in our country are infected with tick-borne encephalitis virus, *Borrelia* (*B. burgdorferi*, *B. garinii*, *B. afzelii*, *B. valaisiana*, *B. lusitanae*, and *B. miyamotoi*), anaplasmas (*A. phagocytophilum*), ehrlichiaspp (*Ehrlichia* spp.), babesias (*Babesia* spp.), rickettsias (*R. helvetica*, *R. monacensis*, and *R. raoultii*).

According to the nature of parasitism, ticks are divided into two ecological groups: pasture and nest-burrowing. Pasture species of mites lay eggs in the forest floor, surface layers of soil, the basal part of the vegetation cover of pastures, meadows, and garden and park areas. Nesting and burrowing – in nests and burrows of various vertebrates [15].

It is proved that the infection of the tick with 2-3 pathogens is not an exception, but a pattern. The share of mixed infections in the tick-borne structure in endemic territories can reach 36% [14].

In different natural and climatic zones, the number and seasonal course of activity of ixod mites are more or less stable and regular. Fluctuations in the number of ticks significantly affect the intensity of the epizootological process in the foci. With high tick activity, the risk of human and farm animals becoming infected with tick-borne infections increases. Outbreaks of some vector-borne diseases are directly related to the number of major vectors in nature [15].

It is known [16] that *I. ricinus* is a parasite in Belarus on 35 types of vertebrate animals. The hosts of this species can be almost all land mam-

mals, many birds, reptiles that inhabit the corresponding biotopes.

At the same time, numerous studies prove that the seasonal dynamics of the number and parasitism of ticks on animals and humans in different years are not the same. It depends on the natural, geographical and environmental conditions, the frequency of detection of ticks in the external environment. The number of recorded individuals of the *Ixodae* family is directly related to the stage of insect development [17].

In general, larvae and nymphs of *Ixodes ricinus* are active all season (starting from March, and in 2020 their appearance was registered in February) with a maximum in May-June and in most areas again in late summer in autumn (August-September) [19].

Classically, the defeat of cattle by adult individuals of *Ixodes ricinus* is detected in the central part of Belarus from April to November. However, it was found that the number of ticks detected on animals correlates with the ambient temperature, so the degree of animal biting at one time or another serves as an index of the weather condition rather than an indicator of the true density of ticks in a given territory. Due to the warming and early onset of spring, as well as the warm and almost uniform autumn-winter period in terms of climate, it is necessary to be prepared for atypical periods of hatching and activity of ixodids [4, 15].

Dermacentor pictus has peaks of activity in May and in the second-third decades of October, but with early warming, they can be detected in April and even in mid-March [15].

It should be noted that the species composition of the main hosts of ixod mites has changed over the past decade. Cattle, goats, horses, and sheep have ceased to be the main hosts of both adult ticks and their larvae due to the use of cultivated pastures for their grazing [15].

Dermacentor pictus is most commonly found on wild mammals living in open areas. The main hosts of the preimaginal phases of *Dermacentor pictus* are small rodents (water, common and european red voles) and hedgehogs. Minor hosts include the small shrew, field mouse, yellow-throated mouse, mole, wood dormouse, squirrel, hare, dog, domestic and wild ungulates [17].

At the same time, the species composition of mite hosts living in the park and forest zones of cities has also changed. In recent years, in many European countries, scientists have noted an increase in the number of ixodic mites not only in natural biocenoses, but also in the territories of urbanized landscapes [3, 7].

Thus, the study of ecological, logistic and phenological regularities of the ontogenesis of ixodid

mites in various climatic zones of the Republic of Belarus, the development of various methods for monitoring and forecasting the number and timing of population growth and increased activity of ixodids are relevant.

The aim of the research. To analyze the spread, species composition and seasonality of ixodic mites attacks in various climatic zones of the Republic of Belarus over the past five years, both among animals and among the population, in order to reason the need to determine new volumes of epizootic measures, to find new, more effective and harmless means of controlling parasites – insecticides, acaricides, repellents, attractants.

Material and methods of research. To assess the seasonal activity of ticks and the seasonality of a number of tick infections information obtained from the following sources were analyzed:

- reporting data of veterinary clinics (private and public) and data of regional veterinary stations on the incidence of small domestic animals and cattle for the period 2017-2020 in the Vitebsk, Minsk and Mogilev regions;
- reporting data of the Ministry of Health of the Republic of Belarus on the incidence of tick-borne encephalitis and Lyme borreliosis for 2016-2020 both in the country as a whole, and in the Vitebsk, Minsk and Mogilev regions;
- own research on the collection of ticks, selection and examination of blood (blood smears).

For own research, ticks were collected by direct collection from dogs, cats and cattleduring 2019-2020 on the territory of Vitebsk and the

Vitebsk region. A thin wooden plank (size 15-20 × 5 cm) with pointed long edges was used for revision of the wool cover.

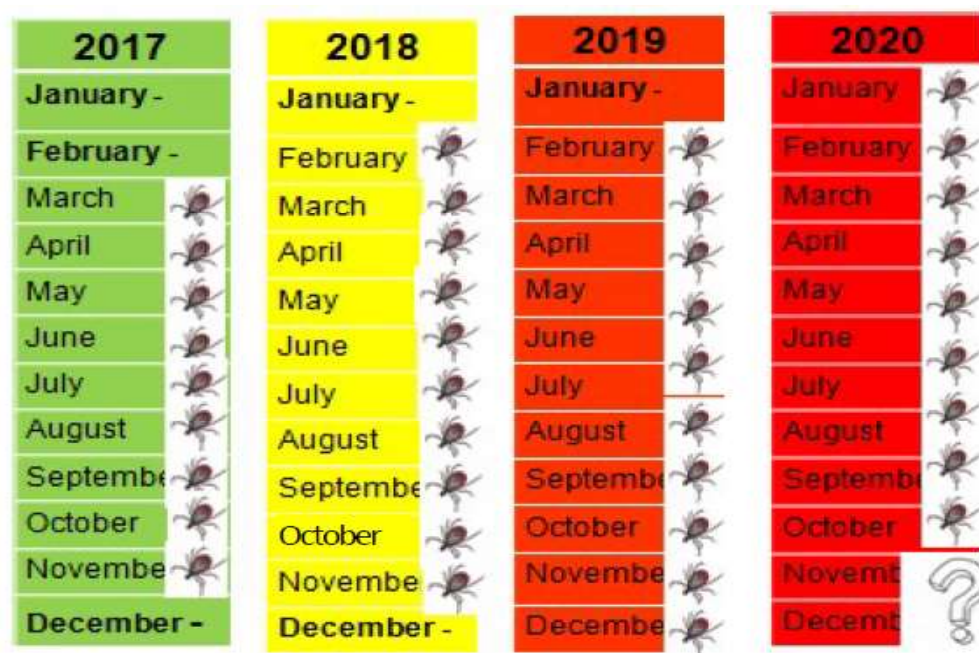
The survey area for the presence of mites is to identify populated and unpopulated areas, the boundaries of these plots, species composition, seasonal dynamics of abundance of these arthropods in pastures (used tools: scraper, box). The area was inspected using the method of route epizootic and regular tick counts in the open nature, near livestock buildings, runs, places of watering and animal recreation. All the data obtained were compared with the designations on the maps-diagrams of the territories of farms.

Ticks were preserved in 70% alcohol or 4-5% aqueous formalin solution. All ticks isolated from each registration collection (from an animal, from pastures, etc.) were placed in a separate containers with the corresponding label.

The generic and species identity of ticks removed from animals was determined using the determinant of N. A. Filippova (1977) [18].

The diagnosis of blood parasitic diseases was made by taking blood samples from the peripheral vessels of dogs, cats and cattle, preparing blood smears, staining them using the Tsil-Nielsen method and microscopy.

Research results and discussion. While studying the season of tick activity in a number of regions of the Republic of Belarus for 2017-2020, it was found (pic. 1) that in recent years, the seasons of tick activity and their attack have shifted.



Pic. 1. Seasons of tick activity in the Republic of Belarus for 2017-2020.

According to the reporting data of a number of private veterinary clinics in 2018-2019, cases of tick attacks on animals were registered almost throughout the year. The only exceptions were January and December 2018 and January 2019. During the 10 months of 2020, tick attacks were recorded continuously, that is, from January to October 2020. The most active mites attacked in the spring-summer period (from April to June) and summer-autumn (from August to October). Comparing these data with 2017, it should be noted that the seasonal tick attack in 2017 in some regions of Belarus was observed from March to November.

When analyzing the climatic and geographical features and features of the mites' habitat (range), it should be noted that mites intensively move from purely forest and field areas towards urban areas (that is, to localities, urban areas), actively inhabiting parks and squares. Collecting anamnestic data in all cases of tick attacks on domestic animals (cats, dogs), it was found that about 50% of all registered cases of tick attacks occurred directly in parks and squares of cities (localities). It should also be noted that tick attacks in some cases occurred in areas with low grass vegetation and in open areas in direct sunlight.

When determining the species composition, we identified two main genera of ticks responsible for the spread of tick-borne infections and infestations-ticks of the genus *Ixodes* and the genus *Dermacentor* (which generally coincides with the studies of other national researchers [4,15,17]). Most often (up to 70% of all collected ticks) we registered ticks of the genus *Ixodes* (figure 1).

In males, the shield covers the entire dorsal side. In females, the shield is small and is located only in the anterior part of the dorsal side, on the other parts of the body, the covers are soft, which

makes it possible to stretch and increase the body volume. The color of males is brown, their length is about 2.5 mm. Length of hungry females – 4 mm, saturated with blood-up to 11 mm).

Our data on the distribution and seasonality of tick attacks provide an explanation for the revealed seasonality in the incidence of piroplasmiasis (babesiosis) in the canid family, which increases from year to year (pic. 2).

If earlier (2013-2016) this pathology was recorded from early April to July and from late August to October, in recent years (2017-2020 years) we found out registration of piroplasmiasis very early: in the 2017 -from March, in 2018 -February, in 2019- February, in 2020- from January.

As can be seen from the presented graphs, in recent years there has been a trend towards the possibility of infection with piroplasmiasis and a number of other infections and infestations throughout the year.

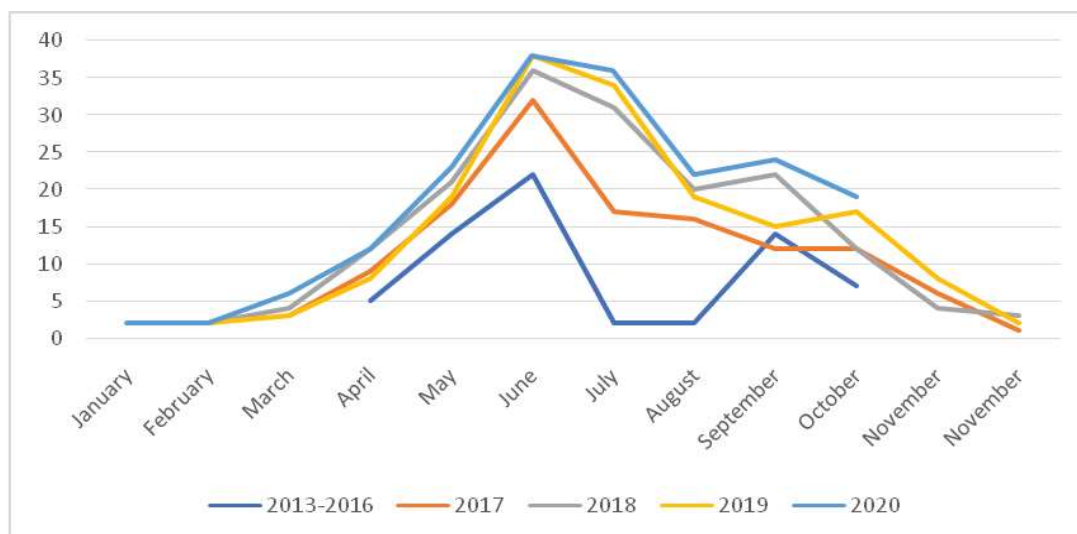
In addition to domestic and wild animals, ixodids pose a significant threat to humans, as they are carriers and keepers of various types of pathogens, including tick-borne borreliosis (Lyme disease) and tick-borne encephalitis. According to our analysis of the available reporting data of the Ministry of Health of the Republic of Belarus, the incidence of diseases carried by ixodidson the territory of the Republic of Belarus has a pronounced tendency to increase annually.

According to sanitary and epidemiological observations, 76% of the area of Belarus is unfavorable by tick-borne encephalitis, 92% - by Lyme borreliosis. Over the past 15 years, the country has diagnosed 10421 cases of Lyme borreliosis in adults and 969 in children, 1262 and 95 cases of tick-borne encephalitis, respectively [20].

According to the epidemiological service of the Republic of Belarus in 2017, the largest



Fig. 1. (own data) On the left is a blood-rich female tick *Ixodes ricinus*, on the right is a male (the body of the mite oval, on the top side is a flap).



Pic. 2. Seasonal incidence of the family of canine pyroplasmosis (babesiosis) in 2013-2020.

number of people affected by tick bites in the Vitebsk region was noted: Vitebsk and Vitebsk region-3354 people, including children under 17 years of age - 669 people, Orsha and Orsha district-414 people, children-197, Novopolotsk-320 people, children-108, Braslav district-192 people, children-58 (pic. 3).

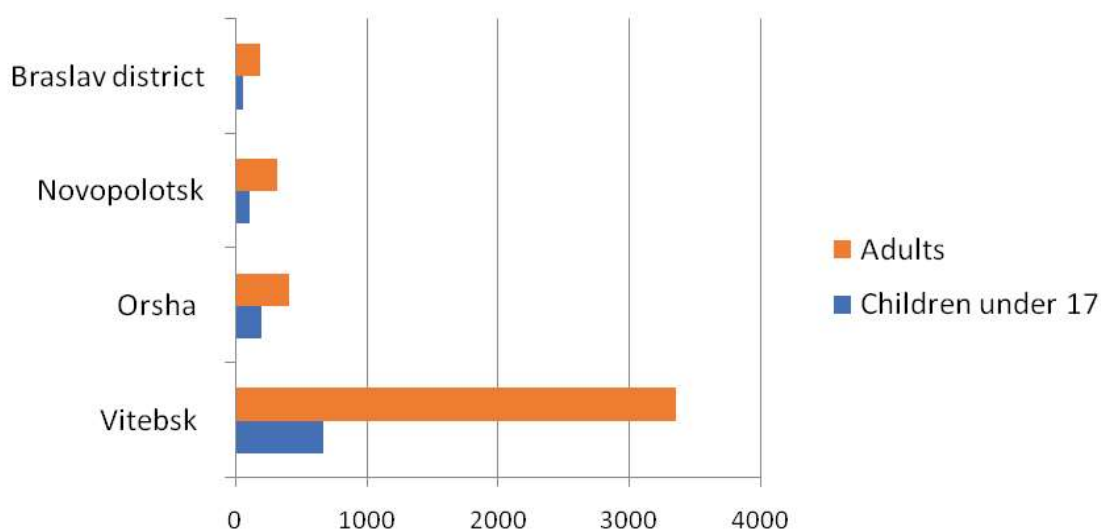
In 2017, the largest number of tick sucking in the Republic occurred in the forest and rural areas – 27951, which accounted for 60.1% of the total number of victims, 4910 cases were detected in the city (pic. 4).

In 2017, the incidence of tick-borne encephalitis in the Republic of Belarus corresponded to the level of 2019, a total of 136 cases of tick-borne encephalitis were registered, and in the

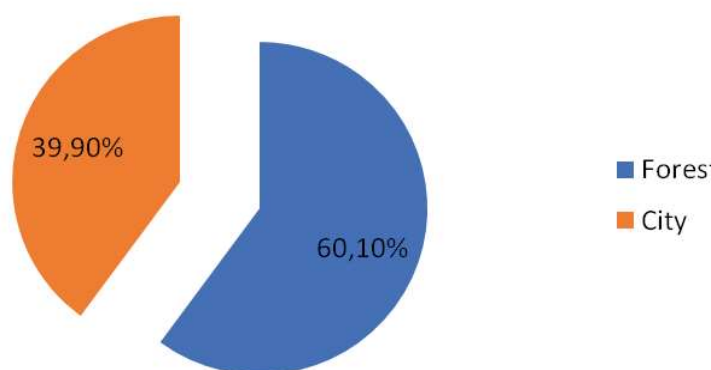
same period of 2016-133 cases; the incidence rate was 1.41 and 1.39 per 100.000 population, respectively. Out of the total number of cases of tick-borne encephalitis registered in 2017, in 5 cases infection occurred through infected goat milk, milk was consumed without boiling (Minsk and Grodno region), a fatal outcome of tick-borne encephalitis was registered, the cause of which was a late request for medical help.

The incidence of Lyme borreliosis in Belarus in 2017 was 1,471 cases, and 196 cases were registered directly in the Vitebsk region.

It is believed that one of the most significant reasons for the incidence of Lyme borreliosis is the disregard of citizens for preventive treatment after a tick bite.



Pic. 3. Persons affected by tick bites in the Vitebsk region in 2017.



Pic. 4. Geographical features of tick-hitting of the population of the Republic of Belarus in 2017.

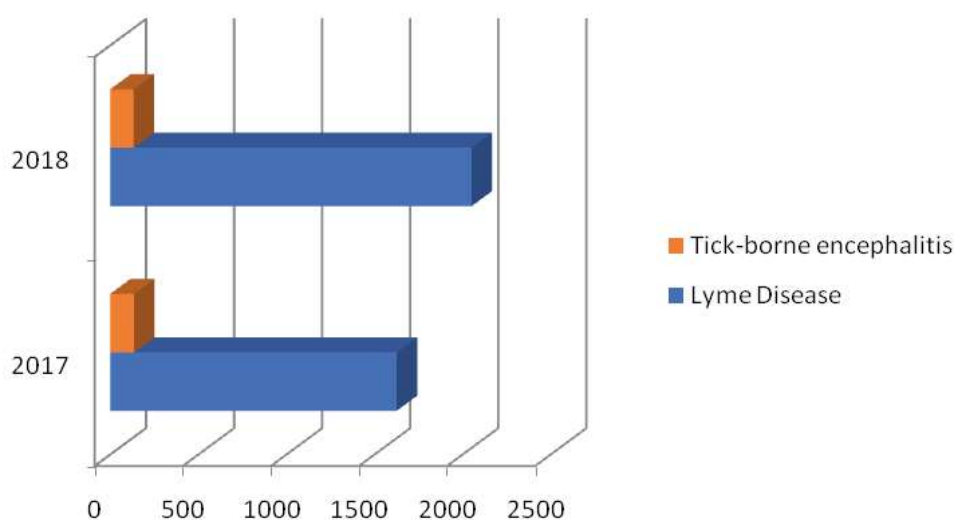
According to the Ministry of Health of the Republic of Belarus, in 2018-2019, 39,242 people, including 10,845 children, applied for medical assistance in connection with ixodic tick bites. The results of microbiological monitoring of the Republican Scientific and Practical Center of Epidemiology and Microbiology showed that a third of ticks were infected with *Borrelia*, and in one of the bioassays in the Grodno region, the infection of ticks with the tularemia pathogen was detected for the first time.

According to health organizations in Belarus, a total of 134 cases of tick – borne encephalitis were registered in 2018 on the territory of the Republic of Belarus (in 2017-136 cases) (pic. 5). The incidence of tick – borne encephalitis exceeding

the national level was recorded in the Grodno region-4.8 per 100 thousand population, as well as in the Brest region – 3.4.

The incidence of borreliosis (pic. 5) increased by 26.1% compared to 2017. In 2018, 2,052 cases of borreliosis were registered (1,627 cases a year earlier). The incidence rate was 21.6 per 100 thousand population (in 2017-17.1). Last year, the incidence of borreliosis exceeding the national level was registered in Minsk-35.9 per 100 thousand population, Vitebsk region – 26.9 cases, Mogilev region-22.6 cases, Grodno region – 22.09.

Discussion. During 2017-2020, possibly due to a sharp warming of the climate, we have established a change in the seasonality of tick attacks on animals and humans. There is a tendency to



Pic. 5. Republican incidence of tick-borne encephalitis and Lyme borreliosis in 2017-2018.

year-round parasitism of ixodids on feeders and, accordingly, almost all-season incidence of tick-borne infections. In addition, the geographical range of diseases transmitted by ticks is changing – today, clinical cases are registered in regions where they were not previously encountered. Our research echoes the work of other authors [21], who also point to these circumstances. So, in Germany and the Netherlands, an outbreak of pyroplasmiasis was noted. In the UK, leishmaniasis, ehrlichiosis, piroplasmiasis and dirofilariasis are registered in animals that have returned with their owners from warm countries.

In recent years, the attention of the medical community of our country brought to the problem of tick-borne infections as evidence that ticks of the genus *Ixodes* can be infected by multiple pathogens, and any disease resulting from the tick bite should be considered as a potential mixtape [1].

All this points need a more in-depth study of the physiology of Ixodid mites and requires more effective monitoring of the tick population, even in non-endemic areas.

Conclusions.

1. The analysis of statistics found that in recent years there has been a trend of the season of activity of ticks and seasonality of tick-borne infections and infestations in the direction of their registration for the entire year (all seasons).

2. The change in the habitat of ticks from purely forest and pasture (wet places with high grass) to open forest and park zones (dry places with low and poor grass, often without it) and their wide spread in the urban zone (park zone with poor grass or without it, yard areas, near 50% cases of ticks attack) was revealed.

3. Extension of the habitat of ticks and their seasonal change in activity led to a rise in the number of registered cases of seasonal infestations and infections among the population (1627 cases in 2017 - Lyme diseases (2052 –in 2018)) and among the domestic animals, cases of previously rare diseases (tick-borne encephalitis (134-136 cases), tularemia (1 cases)).

4. The resulting study data indicate the need for more detailed study of the biology and physiological characteristics of *Ixodes* ticks in the context of their modern climatic and geographical preferences, for the effective monitoring of mite populations to predict the occurrence or increase the incidence of tick-borne infections and infestations, timely prevention and treatment.

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Кліщові інфекції та інвазії в Республіці Білорусь **Суботіна І.А., Осмоловський А.А., Фадеєнкова Є.І.**

На території Республіки Білорусь зберігається зростання інфекційних та інвазивних захворювань людини і тварин, причиною яких є кліщі та комахи. Представляється актуальним вивчення еколого-логістико-фенологічних закономірностей онтогенезу іксодових кліщів в різних кліматичних зонах Республіки Білорусь, розробка різних методів моніторингу і прогнозування кількості, термінів збільшення популяції і підвищення активності іксодид.

Метою дослідження було проаналізувати особливості поширення, видового складу і сезонності нападу іксодових кліщів в різних кліматичних зонах Республіки Білорусь протягом останніх 5 років.

Для визначення сезонної активності кліщів і сезонності ряду кліщових інфекцій та інвазій серед тварин проводили як власні дослідження по збору кліщів, відбору та дослідженню крові (мазків крові), так і збір звітних даних ветеринарних клінік (приватних і державних), даних районних ветеринарних станцій, звітних даних міністерства охорони здоров'я за 2016–2020 рр. для вивчення особливостей сезонної динаміки і клімато-географічних особливостей поширення як самих кліщів-переносників, так і кліщових інфекцій та інвазій серед тварин і населення.

Проаналізовано дані щодо поширення, видового складу і сезонності нападу іксодових кліщів в різних кліматичних зонах Республіки Білорусь. Показана тенденція

до зміни сезону активності кліщів і сезонності кліщових інфекцій та інвазій в сторону їх реєстрації протягом всього року (всіх сезонів року). Виявлено зміну ареалу проживання кліщів і їх широке поширення в урбаністичній зоні. Встановлено зростання кількості зареєстрованих випадків сезонних інвазій та інфекцій, як серед населення, так і серед домашніх тварин.

Ключові слова: іксодові кліщі, кліщові інфекції, кліщові інвазії, Республіка Білорусь.

Клещевые инфекции и инвазии в Республике Беларусь

Субботина И.А., Осмоловский А.А., Фадеенкова Е.И.

На территории Республики Беларусь сохраняется рост инфекционных и инвазивных заболеваний человека и животных, причиной которых являются клещи и насекомые. Представляется актуальным изучение эколого-логистико-фенологических закономерностей онтогенеза иксодовых клещей в различных климатических зонах Республики Беларусь, разработка различных методов мониторинга и прогнозирования количества, сроков увеличения популяции и повышения активности иксодид.

Целью исследования было проанализировать особенности распространения, видового состава и сезонности нападения иксодовых клещей в различных климатических зонах Республики Беларусь на протяжении последних 5 лет.

Для определения сезонной активности клещей и сезонности ряда клещевых инфекций и инвазий среди животных проводились как собственные исследования по сбору клещей, отбору и исследованию крови (мазков крови), так и сбор отчетных данных ветеринарных клиник (частных и государственных), данных районных ветеринарных станций, отчетных данных министерства здравоохранения за 2016–2020 гг. для изучения особенностей сезонной динамики и климато-географических особенностей распространения как самих клещей-переносчиков, так и клещевых инфекций и инвазий среди животных и населения.

Проанализированы данные по распространению, видовому составу и сезонности нападения иксодовых клещей в различных климатических зонах Республики Беларусь. Показана тенденция к изменению сезона активности клещей и сезонности клещевых инфекций и инвазий в сторону их регистрации в течении всего года (всех сезонов года). Виявлено изменение ареала обитания клещей и их широкое распространение в урбаністической зоне. Установлен рост количества регистрируемых случаев сезонных инвазий и инфекций, как среди населения, так и среди домашних животных.

Ключевые слова: иксодовые клещи, клещевые инфекции, клещевые инвазии, Республика Беларусь.



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