Formation of hard ticks’ biotopes on urban territories

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Abstract. On territory of many cities and towns in the Russian Federation, new stable biotopes of hard ticks have been formed up and being occurred constantly. These ticks eat animal and human blood and are agent transmitters of many transmissive tick-born infectious and invasion diseases. They are very stable towards adverse factors of nature environment. The article represents knowledge about risk-oriented monitoring and ixodid tick biotope formation on urban territories. Classification and characteristics of urban territories of contemporary city versus the conditions of ixodid ticks’ biotopes formation and, hence, of focuses of tick diseases are given. For ixodid biotopes eradication in the cities, tick-spread maps should be arranged on the base of geoinformational systems, GIS, and pursue, on their basis, target treatment of greenery with acaricides. GIS can be considered as a research method that might be applied for risk management in retrospective and prognosticating.

1. Introduction

Hard ticks are arachnids, typically 3 to 5 mm long, part of the order Parasitiformes. Along with mites, they constitute the subclass Acari. Ticks are ectoparasites (external parasites), living by feeding on the blood of mammals, birds, and sometimes reptiles and amphibians. Ticks had evolved by the Cretaceous period, the most common form of fossilisation being amber immersion. Ticks are widely distributed around the world, especially in warm, humid climates.

Almost all ticks belong to one of two major families, the Ixodidae or hard ticks, and the Argasidae or soft ticks. Adults have ovoid or pear-shaped bodies, which become engorged with blood when they feed, and eight legs. In addition to having a hard shield on their dorsal surfaces, hard ticks have a beak-like structure at the front containing the mouthparts, whereas soft ticks have their mouthparts on the underside of the body. Both families locate a potential host by odour or from changes in the environment [1].

Ticks have four stages to their lifecycle, namely egg, larva, nymph, and adult. Ixodid ticks have three hosts, taking at least a year to complete their lifecycle. Argasid ticks have up to seven nymphal stages (instars), each one requiring a blood meal. Because of their habit of ingesting blood, ticks are vectors of at infectious and parasitic diseases that affect humans and other animals [2, 3, 4].
On territory of many cities and towns in the Russian Federation, new stable biotopes of hard ticks have been formed up and being occurred constantly. These ticks eat animal and human blood and are agent transmitters of many transmissible infectious and invasion diseases [5, 6, 7]. They are very stable towards adverse factors of nature environment. They can overwinter and bear overflowing of their inhabitation places for 12 days. Ixodid tick females can live in hungry state for 3 years. Besides, they are very fertile. Tick female can lay less than 5 thousand eggs. An extremely important capacity of ticks is to transfer disease agents transovarianally to next generations. So, the territorial areas inhabited with the invasion ticks stay dangerous for decades and represent natural foci of illnesses. Besides, ticks are capable to move on to new territories thanks to master-feeder and as a result they gradually inhabit new territories, forming new for them natural foci of diseases [8, 9].

Aim – to learn specificities and regularities of the formation of ixodid tick biotopes and of tick infections focuses on urban territories and to offer city district classification in the model of risk-oriented monitoring for particular group of diseases.

2. Biotope formation features of ixodid ticks on urban territories.

Originating of foci of infectious and invasion diseases on city and community territories represent a special danger. At present, animals and humans undergo tick’s inroad not in the suburb region (in forest, on dachas and so on) but immediately inside the city. Data have been appeared on the presence of ixodid ticks’ biotopes in the cities and towns and, therefore, the presence of tick transmissive disease focuses in Russian Federation cities and towns.

It causes thinking on reasons and regularities of ixodid tick biotopes formation in modern cities. The living conditions and environment of ixodid ticks in the city drastically differ from those in the natural biotopes. One can outline following specificities inside the city:

- Gas upraised contamination of atmospheric air and oxygen lowered concentration.
- Outlined disunity of tick’s inhabitation. Ticks live only on the areas with greenery, but these areas occupy just insignificant part of the city territory and limited by areas unsuitable for hard ticks’ inhabitation (roads, houses).
- Significant variety of local climate conditions.
- Insignificant, in comparison with natural biotopes, species variety of feeders, as a rule, there are dogs, cats, synanthropic rodents, insect-eaters.
- More often changes in inhabitation environment, connected with construction and building renewal.
- People and transport high density and their active movement.

Pointed conditions have, from our view, undoubted impact on the occurrence and maintaining of tick inhabitation areas inside the cities.

All territory of modern cities can be conveniently divided into "old", "young" and "new-built".

Old part of the cities is more than 50 years old construction territory. It is characterized by high level of urbanization and, hence, gas high contamination and small amount of greenery. As a rule, this zone is almost free from ticks. In this zone limits, ticks can inhabit parks, boulevards and yards where bushes are. The major factor of tick intake and movement here are animals-feeders among which domestic dogs have the most important epizootic significance. The dogs are taken out to suburb area to unsafe in terms of tick diseases districts. Returning to constant living places, they can bring ticks on them which, in its turn, fed up with blood and laying eggs, form the new focus.

According to our observations, on Moscow territory, the cases of tick new biotopes occurrence are constantly located. Thus, we located 3 cases of tick attacks on dogs on small and with poor greenery
square for dog outside walk in Basman district; the square was free from ticks earlier and, as to information obtained from dog owners, the dogs were not taken out of the local district. We located similar cases of sudden occurrence of biotopes at different years in some Moscow districts which are nearby National Park "Losiniy Ostrov", Sokolniki and Bitsevsky park.

Nevertheless, it is worth to note that, in many cities of Russian Federation, parks and boulevards are in downtown area, and, often, city downtown is built up with private sector. In these cases, the number of ticks in these zones is insignificant but their attacks will be registered regularly.

It should be mentioned that to form tick biotope not the amount of greenery has a big importance but the presence of animal-feeders. The cases of tick attack are often located on the areas with too insignificant amount of bushes and grass in the yards and small wasteland squares.

Young districts have construction buildings of ages between 3 to 50. Sufficient forming up of the landscape is their characteristic feature, together, these territories urbanization is lower than in the first zone (more greenery is projected just from the beginning while building up the new districts last decades if to compare with earlier times). Tick biotopes have time to be formed during the landscape creation span. This zone can be conventionally divided into 2 subzones:

- territories where ticks were absent;
- territories where ticks earlier existed.

Biotope formation constituted, as a rule, longtime process in subzones where hard ticks were absent. Ticks are being taken here from outside by animal-feeders. Then, getting on the plants, the fed up females lay eggs which lavras are brooded from. If they find feeders for themselves, the new area of tick inhabitation is being gradually formed.

Subzones, where ticks were earlier, represent areas in young districts where, for some reasons, the construction has not taken place. It can be already existed parks, boulevards and wood lines which were decided to be preserved. Ixodid biotopes are preserved here, and, from here, ticks inhabit neighboring territories. The bright example, from our opinion, is the construction of new micro-districts and living complexes on the territory of former lands for agricultural purposes (pastures and farms) and on the areas earlier not used (waste land, wood etc). In this case, as a rule, ixodid biotopes situated in adjoining woodlands become the place of outdoor walk for dogs brought by new citizens.

That is why young districts in a whole can have fair tick inhabitation.

New built districts - are those where construction is taking place at present or finished less than 3 years ago. The construction changes natural landscape drastically that at most leads to ticks dying. Occupation of given territory with ticks' proceeds step by step and simultaneously with new landscape forming via intake by animal-feeders or via natural hard ticks' migration from adjoining tick-inhabitation zones. In a whole, new-built areas are characterized by tick absence or rather low tick inhabitation.

It should be marked that greenery around ring roads, national parks and nature conservational territories, situated immediately in city limits or flanked therein, as well as agriculture assigned lands represent possible epidemic danger. Tick diseases agents of agricultural, domestic and wild animals as well as of human can circulate on these areas.

Besides, we want to outline that agricultural animals kept in the private sector of city limits and in the suburbs (mainly, goats) can also be exposed to tick’s attack. Together, while the feeding of animals infected with ixodid tick-borne encephalitis virus the risk factor of agent transfer to human appears via the milk of ill animals.

Together, from our opinion, alternative classification of city territories to highly-, poor- and non-urbanized can be applied. Correspondingly, industrial zones and living micro-districts with shallow greenery amount can be related to the first one, well greened up micro-districts and private sector can be
related to the second one, greenery along ring roads, national parks and nature conservation territories located immediately in the city limits or adjacent therein as well as the lands of agricultural prescription – to the third one.

3. Application of geoinformation systems for risk-oriented monitoring of tick diseases
Tick situation in some communities and in a whole, across the country, must be studied specifically and purposefully while close cooperation with veterinary service, State Sanitary Control of all levels and ecologists. It will give a possibility to compose the maps of epizootically and endemically dangerous zones and come up with particular events to struggle with ixodids and illnesses transmitted by them.

To monitor animal and human illnesses the cartographic method is widely applied, the method allows to learn the regularities of spatial location of investigation subjects and to learn some aspects of illness epizootic development on the particular territory by the drawing up and the usage of nosological maps that can be considered as an investigation method applied in retrospective and in forecasting.

Because of the development of modern informational technologies, the computational cartography steps up to a completely new level due to usage of such programming product as geoinformational systems (GIS) which allows to create a map not only as an illustration but as a research and analytical instrument.

Thanks to GIS the major drawbacks of regular maps are overcome (data static character and roominess limitation of the paper as a data carrier), scale widening, and data details are provided.

Epizootic GIS – is an informational system allowing to pursue gathering, storage and analysis of epizootic information with the possibility of its reflection on geographical maps and of reports arrangement according to set up parameters. GIS usage allows to research fuller the epizootic process regularities and animal and human illness geography, and to refine up on its basis the epizootic analysis methodology in deep longtime perspective as well as in short time spans. GIS databases allow to pursue current and retrospective monitoring of epizootic and epidemiological situation on the basis of resulting reports of veterinary and medical organizations and controlling authorities [2].

GIS is an ideal instrument for risks analysis and the monitoring of nature-focus parasitical illnesses of animals and human. In comparison with regular epizootic maps with limited possibilities of legend filling in with data and of process dynamics reflection in space and time, GIS allow to collect, process, model and analyze data of unlimited volume depending on task being settled and also to display them on computer screen or on a hard copy. Along, it is possible the map demonstration in various scales and as separate parts (from whole country map to small local biotope) and of the map various layers.

GIS application for risk monitoring and assessment of infections and invasions, which vectors are ixodid ticks, will let create the united system where tick-transmitter sites and epidemiological characteristics of animal and human illnesses transmitted by them are shown in. It is possible to demonstrate current and retrospective situation on tick diseases of animals and human, their seasonal, species dynamics, loimopotential and from various GIS layers.

4. Conclusion
Stationary tick biotopes have been formed in many contemporary cities at the moment.

Tick amount is not big in the thoroughly built up parts (central ones, as a rule) of the city. Ixodid ticks’ biotopes can be localized in far ago existing parks and boulevards. Ticks also are either absent or their amount is quite slight in newly built-up districts.

The largest tick inhabitation is a characteristic for young, well-made green districts (located on the city outskirts as a rule). Tick biotopes here are in saved greeneries and are gradually forming into new ones.

Ticks transfer to new biotopes is made by animal-feeders (there are dogs and synanthropic rodents as a rule). Moreover, because of human factor, this process is difficult to be controlled. The domestic dogs are
taken out to troubled, in terms of tick diseases, districts where they take ticks back from. That creates disease new focuses.

Tick natural focuses of animals and human diseases form in the cities simultaneously with ixodid biotopes.

To liquidate tick biotopes in the cities it is needed to compose epidemiological maps of tick inhabitation territories on the base of GIS and to hold targeted treatment of greenery by aricides according to these maps.

Creation of integrated with GIS, specialized and multi-level database reflecting epizootic and epidemiological situation on tick illnesses and being composed on the basis of modern and retrospective data with close collaboration with veterinary service. State Sanitary Control centers of all levels will allow to pursue analysis and evaluation of risks effectively, to forecast the situation and to work out particular events on struggle with ixodids and diseases transmitted by them.

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