UDC 636.09:576.89:591.69:595.42
DOI: 10.31073/vet_biotech42-15

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STUDY OF DISTRIBUTION AND SPECIES COMPOSITION OF TICKS IN THE SOUTH AND SOUTH-EASTERN REGIONS OF UKRAINE

The article presents the results of studying the prevalence and species composition of ticks in the southern and south-eastern regions of Ukraine. During 2019-2021 15644 ticks were collected in Odesa, Kherson, Mykolaiv, Zaporizhzhia and Kharkiv regions. Three species of ticks were identified: Dermacentor marginatus – 7230 individuals (46.2% of all collected ticks), Ixodes ricinus – 5317 individuals (34.0%) and Hyalomma marginatum – 3097 individuals (19.8%). It has been established that Dermacentor marginatus is the dominant species among ticks found in Odesa (68.0% of the total number of ticks collected in the region), Kherson (50.8%), Zaporizhzhia (41.4%) and Kharkiv (88.1%) regions. In Mykolaiv region, ticks of the species Ixodes ricinus are most common (53.2%). The prevalence of Hyalomma marginatum ticks does not exceed the prevalence of other types of ticks in any of the regions, however, their largest number was found in Mykolaiv region (43.53%), and the smallest – in Kharkiv region (0.17%).

Keywords: vectors, ticks, Hyalomma marginatum, Ixodes ricinus and Dermacentor marginatus, distribution, infectious diseases.

Introduction. Vector-borne diseases are major contributors to the global disease burden. They are responsible for >17% of all infectious disease and 1 million deaths annually. Control of insect vectors is often the best, and sometimes the only, way to protect humans from these destructive diseases. Vector control is a moving target with globalization and demographic changes causing changes in infection patterns (e.g., rapid spread, urbanization, and appearance in nonendemic countries); and the current unprecedented degradation of the global environment is affecting rates and patterns of vector-borne disease in ways that are still largely unknown [1].
Vector-borne diseases represent a wide variety of biologic systems. Vector control can reduce transmission of pathogens from arthropods, but the activities involved will vary according to many factors – from the vector species to resource availability. At a general level, vector control can be divided into personal protection and community protection. Some of the interventions are the same for each, but personal protection reduces bites on the individual person, whereas community protection achieves population-level effects on the vectors, either by reducing their numbers or by shortening their population longevity [2].

Vector-borne diseases are common infectious diseases. Surveillance for species, quantities, and carried pathogens of vectors can contribute to early detection and early warning of abnormalities that lead to the emergence and transmission of infectious diseases and to timely adoption of measures to reduce the risk of prevalence of vector-borne diseases [3].

Infectious disease vectors are living organisms that can transmit infectious agents between people, between animals, from animals to people, and vice versa. Many of these vectors are blood-sucking insects that ingest pathogens while sucking the blood of an infected host (human or animal). Once the pathogen has multiplied within the vector, it can be transferred to a new host. Also, the vector can be a mechanical carrier of the pathogen from one person/animal to another person/animal. Often, when a vector becomes infected, it is able to be a reservoir for the pathogen and transmit it for the rest of its life during each subsequent bite/blood feed.

Vector diseases are one of the biggest threats to humans and animals. The main vectors of infectious diseases are mosquitoes, ticks, bedbugs, midges, fleas. Ticks are the second most important vectors of infectious diseases after mosquitoes, creating great problems for the health of people and animals around the world [4, 5].

Ticks are external, temporary, obligate parasites of vertebrates (birds, mammals, and reptiles) that need to feed on blood and certain climatic conditions to survive. A hot and humid climate contributes to their survival, while low temperatures hinder their development [6].

Ticks are divided into three families: *Ixodidae*, *Argasidae*, *Nuttalliellidae*. The most common and most important, in terms of transmission of pathogens, are ticks of *Ixodidae* family, which are also called hard ticks, due to the presence of a hard chitinous shield covering the entire dorsal surface of an adult male. In an adult female, as well as in a larva and a nymph, it extends only to a small area. The next largest family is *Argasidae*, or soft ticks, so named for their lack of a shield. The smallest family is *Nuttalliellidae*, to which only one species belongs [7, 8].

Among the hard ticks, the genus *Ixodes* is the largest, it includes 217 species. Other genuses of importance in terms of infectious disease transmission are
Dermacentor, Haemaphysalis, Rhipicephalus, Hyalomma, and Amblyomma [7]. The most important soft ticks are genuses Ornithodoros, Argas, and Otobius [8].

Ticks can carry bacteria, viruses, and protozoa that can cause disease in humans and animals [9]. Some tick species can transmit pathogens from wild animals (eg, rodents) to humans [10], and transmission can also occur through domestic animals [11].

The risk of transmission is determined by the prevalence of ticks in the environment and the possibility of an encounter between an infected tick and a susceptible host [10].

Usually, the host is infected through the infected saliva of the tick during its feeding, but other ways are also possible, in particular, through the consumption of infected ticks, through the tissues of dead infected animals, the consumption of unpasteurized milk, and blood transfusion [12]. Many ticks can be infected with two or more pathogens and transmit them simultaneously [13, 14]. This is especially often observed in ticks of the species Ixodes ricinus, which feed on different types of vertebrates, which are reservoirs for many pathogens [15, 16].

In addition, hosts can be simultaneously infected with several pathogens of infectious diseases during the bites of different ticks at different times [12].

Ukraine is endemic for many natural focal diseases, most of which are especially dangerous infections common to humans and animals [17]. That is why the study of vectors’ populations of these diseases is relevant. The study of the species composition of ixodid ticks in Ukraine at different times was carried out by I.A. Akimov, I.V. Nebogatkin [18], V.A. Levytska, A.B. Mushynskyi [19], Artem S. Rogovskyy, Igor V. Nebogatkin, Glen A. Scoles [20].

The goal of the work is to study the distribution and species composition of ticks as vectors of infectious diseases at the territories of possible contact between tick-animal, tick-human in the southern and south-eastern regions of Ukraine.

Materials and research methods. The collection of ticks was carried out within the framework of a joint international scientific project “Strengthening biosecurity in the fight against pathogens of animal diseases that are critical for spread in Ukraine” between State Scientific and Research Institute of Laboratory Diagnostics and Veterinary and Sanitary Expertise (SSRILDVSE), Ukraine, and Friedrich-Loeffler-Institut (FLI), Germany. The research was funded by the German Ministry of Foreign Affairs.

Ticks were collected during 2019-2021. In 2019 ticks were collected in Odesa, Kherson, Zaporizhzhia and Kharkiv regions; in 2020 – in Odesa, Mykolaiv, Kherson, Zaporizhzhia regions; in 2021 – in Odesa, Kherson, Mykolaiv, Zaporizhzhia and Kharkiv regions.
Ticks were collected in spring and autumn by the following methods:

1) *Collection of ticks by flag method.* “Flag” – flannel, waffle or any other fleecy fabric of white color, 50 cm by 100 cm in size, on the front and back edges of which sticks are attached, on the front edge at the ends of the stick a rope 2 m long is attached (Fig. 1). To stimulate the attack of ticks on the “flag”, it was kept in a room for farm animals (cattle, pigs, goats, birds and others) for 12–24 hours, or pets (cats, dogs) were lying on it for some time before use. The collector in an anti-tick suit slowly dragged the “flag” along the grass of the study area by the rope. The length of the route was calculated by 25 m segments, having previously determined how many steps the collector had in 25 m. In the intervals between segments, stops were made to collect ticks from the “flag” and make appropriate recordings. Each route was at least 2 km long.

![Fig. 1. Schematic representation of the “flag”.

2) *Collection of ticks from animals.* Ticks were collected from animals that have not been treated with insecticidal preparations and were grazing or walking in the territory where ticks were recorded (natural foci). These locations remained constant throughout the observation period. Control animals have been selected and only these animals were examined during the entire examination period.
The collection of ticks from cattle, sheep and goats, dogs was carried out manually. Cattle were examined during daytime or evening milking, sheep and goats or dogs were examined after grazing or walking. At the same time, the animals were well examined and the entire surface of the body was probed with hands, paying special attention to the places of the most probable attachment of ticks: dewlap, intermaxillary space, auricles, eyelids, groin area, udder, tail base, inner thighs, anus area and belly. The detected ticks were removed from the animals and placed in a test tube with a label indicating the type of animal, the name of the settlement, region, and the date of collection.

Ticks were collected during the hours of their maximum activity. Tick collection in sunny weather was carried out in the morning (before the onset of heat and from the moment the dew dried up) from 8–9 to 11–12 am and in the evening from 4–5 to 7–8 pm in the absence of dew and strong wind. On very hot days, morning tick collection was completed earlier and started later in the evening. In cloudy weather, the collection was carried out all daylight hours, starting at 11 am.

Tick’s species belonging was determined based on the morphological structure of ticks under laboratory conditions. Before the study, ticks were placed in Petri dishes, which were placed in a cooling element. The cooling element was placed in a white cuvette with high sides. After the ticks ceased their activity and became immobile, they were examined using stereoscopic and conventional microscopes.

**Research results and discussion.** During 2019-2021 15 644 ticks were collected in five southern and south-eastern regions of Ukraine (Odesa, Kherson, Mykolaiv, Zaporizhzhia and Kharkiv). In percentage terms, in each region, depending on climatic conditions, the prevalence of different types of ticks was different. Three types of ticks were identified: *Dermacentor marginatus* – 7230 individuals (46.2% of the collected ticks), *Ixodes ricinus* – 5317 (34.0%), and *Hyalomma marginatum* – 3097 (19.8%) (Table 1).

In 2019, during the collection of ticks in Odesa, Kherson, Zaporizhzhia and Kharkiv regions, 3528 ticks were identified, of which 96.9% of individuals were ticks of the species *Dermacentor marginatus*, 2.1% were *Hyalomma marginatum* and 1.0% – *Ixodes ricinus*.

In 2020, 7466 ticks were identified in Odesa, Mykolaiv, Kherson and Zaporizhzhia regions, of which the most common are *Ixodes ricinus* ticks – 44.9% of individuals, *Dermacentor marginatus* – 36.7% and less *Hyalomma marginatum* – 18.4%.
Table 1

Species composition of ticks collected in Southern and South-Eastern regions of Ukraine in 2019-2021

<table>
<thead>
<tr>
<th>Region</th>
<th>Quantity of ticks, psc.</th>
<th>Hyalomma marginatum</th>
<th>Dermacentor marginatus</th>
<th>Ixodes ricinus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odesa</td>
<td>67  77  213</td>
<td>756  1272  446</td>
<td>5  420  381</td>
<td></td>
<td>3637</td>
</tr>
<tr>
<td>Mykolaiv</td>
<td>-  855  451</td>
<td>-  9  89</td>
<td>-  1136  460</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>Kherson</td>
<td>2  162  440</td>
<td>1125  926  0</td>
<td>2  823  560</td>
<td></td>
<td>4040</td>
</tr>
<tr>
<td>Zaporizhzhia</td>
<td>2  280  546</td>
<td>975  531  61</td>
<td>23  975  393</td>
<td></td>
<td>3786</td>
</tr>
<tr>
<td>Kharkiv</td>
<td>2  -  0</td>
<td>564  -  476</td>
<td>5  -  134</td>
<td></td>
<td>1181</td>
</tr>
<tr>
<td>Total</td>
<td>73  1374  1650</td>
<td>3420  2738  1072</td>
<td>35  3354  1928</td>
<td></td>
<td>15644</td>
</tr>
</tbody>
</table>

As noted in Table 1, during 2021, 4650 ticks were found in Odesa, Kherson, Mykolaiv, Zaporizhzhia and Kharkiv regions, of which 41.5% of individuals were ticks of the species *Ixodes ricinus*, 35.5% – *Hyalomma marginatum* and 23.0% – *Dermacentor marginatus*.

The ratio of different species of ticks by regions is shown in Fig. 2.

![Fig. 2. Ratio of different species of ticks in Southern and South-Eastern regions of Ukraine in 2019-2021.](image)

In Odesa region, the most common ticks were *Dermacentor marginatus* (68.02% of the collected ticks), then *Ixodes ricinus* (22.16%) and *Hyalomma marginatum* (9.82%).
In Mykolaiv region ticks of the species *Ixodes ricinus* (53.20%) were the most common, then *Hyalomma marginatum* (43.53%) and *Dermacentor marginatus* (3.27%).

In Kherson region the most common ticks were *Dermacentor marginatus* (50.77%), then *Ixodes ricinus* (34.28%) and *Hyalomma marginatum* (14.95%).

In Zaporizhzhia region the most common ticks were *Dermacentor marginatus* (41.39%), then *Ixodes ricinus* (36.74%) and *Hyalomma marginatum* (14.95%).

In Kharkiv region the most common ticks are *Dermacentor marginatus* (88.06%), then *Ixodes ricinus* (11.77%) and *Hyalomma marginatum* (0.17%)

**Conclusions and prospects for further research:**

The results of our research highlight the species composition of ticks in the areas of the most probable tick-animal and tick-human contact, which is important from the point of view of the emergence and spread of vector-borne diseases.

It was established that *Dermacentor marginatus* was the dominant tick species found in Odesa (68.02% of the total number of ticks collected in the region), Kherson (50.77%), Zaporizhzhia (41.39%) and Kharkiv (88.06%) regions. In Mykolaiv region, ticks of the species *Ixodes ricinus* were the most common (53.20%). The prevalence of *Hyalomma marginatum* ticks did not exceed the prevalence of other types of ticks in any of the regions, however, their largest number was found in Mykolaiv region (43.53%) and the smallest – in Kharkiv region (0.17%).

In the future it is necessary to conduct research on ticks to identify the genomes of pathogens of infectious diseases that can be transmitted by these types of ticks in order to determine the degree of invasiveness of ticks and their role in the spread of diseases.
Матеріали та методи дослідження. Збір кліщів здійснювався в рамках спільного міжнародного наукового проекту «Посилення біозахисту у боротьбі зі збудниками критичних щодо поширення в Україні хвороб тварин» між Державним науково-дослідовним інститутом з лабораторної діагностики та ветеринарно-санітарної експертизи (м. Київ, Україна) та Інститутом Фрідріха Льоффлера (Німеччина). Дослідження фінансувалося Міністерством закордонних справ Німеччини.


Видова принадлежність кліщів визначалася, виходячи з морфологічної будови кліщів. Морфологічну ідентифікацію кліщів проводили у лабораторних умовах. Перед дослідженням кліщі розміщували у білій кювету з високими бортами. Після того як кліщи припиняли свою активність і ставали нерухомими, їх досліджували за допомогою стереоскопічного та звичайного мікроскопів.

Результати досліджень та їх обговорення. Протягом 2019–2021 pp. було зібрано 15644 кліща в Одеській, Херсонській, Миколаївській, Запорізькій та Харківській областях. Виявлено три види кліщів: Dermacentor marginatus – 7230 екз. (46,2% від усіх зібраних кліщів), Ixodes ricinus – 5317 екз. (34,0%) та Hyalomma marginatum – 3097 екз. (19,8%). Встановлено, що Dermacentor marginatus є домінантним видом серед кліщів, виявлених на Одещині (68,0% від загальної кількості кліщів, зібраних в області), в Херсонській (50,8%), Запорізькій (41,4%) та Харківській (88,1%) областях. На Миколаївщині найбільш поширені кліщи виду Ixodes ricinus (53,2%). Поширеність кліщів Hyalomma marginatum не перевищує розповсюдженості інших видів кліщів у жодному регіоні, проте найбільша їх кількість виявлена в Миколаївській області (43,53%), а найменша – у Харківській (0,17%).

Висновки та пропозиції:
1. Результати наших досліджень дозволяють виділити видовий склад кліщів в зонах найбільш ймовірного контактів кліщів з тваринами та людьми, що важливо з погляду виникнення та поширення трансмісивних хвороб.
2. Встановлено, що Dermacentor marginatus був домінантним видом кліщів, виявлених в Одеській (68,02% від загальної кількості кліщів, зібраних в області), Херсонській (50,77%), Запорізькій (41,39%) та Харківській (88,06%) областях. На Миколаївщині найбільш поширені кліщи виду Ixodes ricinus (53,20%). Поширеність кліщів Hyalomma marginatum не перевищує розповсюдженість інших видів кліщів у жодному регіоні, проте найбільша їх кількість виявлена в Миколаївській області (43,53%), а найменша – у Харківській (0,17%).
3. Надалі необхідно провести дослідження кліщів для виявлення геномів збудників інфекційних захворювань, які можуть передаватися цими видами кліщів, з метою визначення ступеня інвазивності кліщів та їхньої ролі у поширенні хвороб.

Ключові слова: переносники, кліщі, Hyalomma marginatum, Ixodes ricinus та Dermacentor marginatus, поширення, інфекційні хвороби.
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