

Distribution and Some General Features of the Ecology of *Ixodes trianguliceps* Bir. in the Soviet Union

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Abstract. A cadastre-reference map of the distribution of *Ixodes trianguliceps* Bir. has been drawn up on the basis of careful analysis and pertinent study of the earlier published communications. It depicts all known localities where ticks of this species have been found in the Soviet Union and defines the supposed boundary line of their distribution area.

The ticks of the species *Ixodes* (*Exopalgiger*) *trianguliceps* are widely spread in Eurasia. They have been found in England (NUTTALL and Warburton 1911), Germany (SCHULZE 1944), Sweden (BRINCK et al. 1967), Denmark (ARTHUR 1955), Switzerland (AESCHLIMANN et al. 1965), Austria (RADDA et al. 1963), Italy (STAROKOF 1958), Czechoslovakia (ROSICKÝ 1953; LICHARD 1965 etc.), Hungary (BABOS 1965), Bulgaria (DRENSKI 1955), Rumania (FEIDER 1965), Poland (LACHMAJER 1962). A considerable part of the distribution area of this species is located in the Soviet Union. At present, however, it is difficult to obtain a relatively general idea about its boundaries. In monographs on ixodid ticks (POMERANTSEV 1950; SERDYUKOVA 1956; BABOS 1965 etc.), as a rule, only few localities where this species has been found, are listed. Available is only an extremely incomplete map (especially as regards the eastern part of the distribution area) in the report of FEIDER (1965).

The present distribution area of *I. trianguliceps* is of great interest for the study of evolution and zoography of ixodid ticks, in particular of the subgenus *Exopalgiger* as pointed out for the first time by B. I. POMERANTSEV (1948). In recent years the ticks *I. trianguliceps* have attracted greater attention of researchers in connection with their possible role in natural foci of tick-borne encephalitis (SOLOVYEV 1944; MALYUSHINA and KATIN 1965 etc.), haemorrhagic fever with a renal syndrome (BASHKIREV, BOYKO 1966; PANINA, KATELINA 1966 etc.) and tularemia (OLSUFJEV, DUNAYEVA 1960 etc.).

The mentioned problems cannot be solved without a clear perception about the peculiarities of distribution of *I. trianguliceps*. Therefore, we have set up a task

Table 1. Hosts of the ticks *I. trianguliceps* in various zones of the USSR

Host species	Central taiga	Southern taiga	Broad-leaved-coniferous and broad-leaved forests	Forest-steppe	Mountains of southern Siberia	The Caucasus
<i>Talpa europaeus</i> L.	+	+	+			+
<i>Talpa altaica</i> Nik.	+	+				
<i>Sorex minutissimus</i> Zimm.		+				
<i>Sorex minutus</i> L.		+				
<i>Sorex vir</i> G. Allen		+				
<i>Sorex daphaenodon</i> Thom.		+				
<i>Sorex arcticus</i> Kerr.		+				
<i>Sorex centralis</i> Thom.		+				
<i>Sorex caecutiens</i> Thom.		+				
<i>Sorex araneus</i> L.		+				
<i>Neomys anomalus</i> Fabr.		+				
<i>Neomys fodiens</i> Tenn.		+				
<i>Crocidura suaveolens</i> Pall.		+				
<i>Crocidura leucodon</i> Herm.		+				
<i>Nyctalus noctula</i> Schr.		+				
<i>Vulpes vulpes</i> L.		+				
<i>Mustela nivalis</i> L.		+				
<i>Lepus timidus</i> L.		+				
<i>Lepus europaeus</i> Pall.		+				
<i>Ochotona alpina</i> Pall.		+				
<i>Sciurus vulgaris</i> L.		+				
<i>Eutamias sibiricus</i> Laxm.		+				
<i>Citellus suslicus</i> Guld.		+				
<i>Sicista betulina</i> Pall.		+				
<i>Rattus norvegicus</i> Berk.		+				
<i>Mus musculus</i> L.		+				
<i>Apodemus agrarius</i> Pall.		+				
<i>Apodemus speciosus</i> Temm.		+				
<i>Apodemus sylvaticus</i> L.						
<i>Apodemus flavicollis</i> Melch.						
<i>Micromys minutus</i> Pall.						
<i>Cricetus cricetus</i> Pall.						
<i>Myopus schisticolor</i> Lill.						
<i>Clethrionomys glareolus</i> Schr.						
<i>Clethrionomys rutilus</i> Pall.						
<i>Clethrionomys rufocanus</i> Sund.						
<i>Arvicola terrestris</i> L.						
<i>Microtus arvalis</i> Pall.						
<i>Microtus agrestis</i> L.						
<i>Microtus oeconomus</i> Pall.						
<i>Microtus socialis</i> Pall.						
<i>Microtus subterraneus</i> Sel-Longch.						
<i>Microtus majori</i> Thom.						
<i>Microtus gud</i> Sat.						
<i>Microtus nivalis</i> Mart.						
<i>Microtus gregalis</i> Pall.						
<i>Prometheomys schaposchnikovi</i> Sat.						
<i>Dendrocopus major</i> L.						
<i>Anthus trivialis</i> L.						
<i>Turdus viscivorus</i> L.						
<i>Emberiza citrinella</i> L.						
<i>Carduelis carduelis</i> L.						
<i>Lacerta vivipara</i> Jac.						

of drawing up a precise cadastre-reference map of localities in the territory of the Soviet Union, where this tick occurs and of defining the boundaries of its distribution area according to the present knowledge.

MATERIAL AND METHODS

In order to draw up a distribution map of *I. trianguliceps* in the USSR, all papers dealing with this tick have been taken as a basis, from the publication of A. A. BIRULYA (1895) (who was the first to detect this species in this country) to the reports of 1967 inclusive. These have been supplemented by data made available by courtesy of parasitologists working at some regional stations of hygiene and epidemiology.

All information on ticks of the given species obtained from the publications has been coded on a separate standard two-line punched card by means of specially selected code-keys (KORENBERG, LEBEDEVA 1966). Each locality of *I. trianguliceps* has been given a serial number and has been coded. Simultaneously under these numbers the localities have been recorded on the map total. In accordance with the method recommended for drawing up cadastre maps (TUPIKOVA, TESLENKO 1967) each locality has been numbered, whenever several geographic points were given in one publication. On the other hand, whenever a paper included a reconnaissance map without precise description of the localities where the species was found, all marks have been numbered under one same number. This number has been coded on all punched cards including information about ticks found in one locality. In this way a complete cadastre has been obtained on the punched cards. It is deposited at the Medical Zoology Laboratory of the Gamaleya Institute of the USSR Academy of Medical Sciences. In the present paper we consider it necessary to refer to publications on the basis of which the map giving localities of the tick's occurrence, has been drawn up. The list of literature includes in brackets numbers corresponding with the numbers of localities on the map. The localities of *I. trianguliceps* have been recorded on a map to the scale 1 : 10,000,000, which has been subsequently simplified and reduced by photomechanical method. Whenever a precise locality was given in a publication, it has been marked off on the map by a black point. In many papers only districts are given, within which the tick *I. trianguliceps* occurs. In such cases a circle has been marked off in the district centre on the map.

RESULTS

The studies carried out to date show that *I. trianguliceps* is widely distributed over the territory of the Soviet Union (see Fig. 1). Its distribution area consists of two parts isolated from each other. The larger part of the area is mainly in the forest zone, the smaller one embraces the mountain regions of the Crimea and the Caucasus. The northernmost locality has been recorded by T. N. DUNAYEVA et al. (1961) on the river Tsimla approximately in latitude 65°20' North (map: No. 48). If we do not take into account the data of E. F. SOSNINA (1954) on the occurrence of *I. trianguliceps* at the southern slope of the Gisar mountain ridge in Tadzhikistan (No. 50), which in our opinion needs to be confirmed, then the southernmost locality (No. 17) is the area of the village Bakuriani in Georgia. In eastern direction the ticks *I. trianguliceps* are spread as far as the Khamar-Daban mountain ridge (No. 78) approximately in longitude 106° East (YEMELYANOVA, PAULLER 1957).

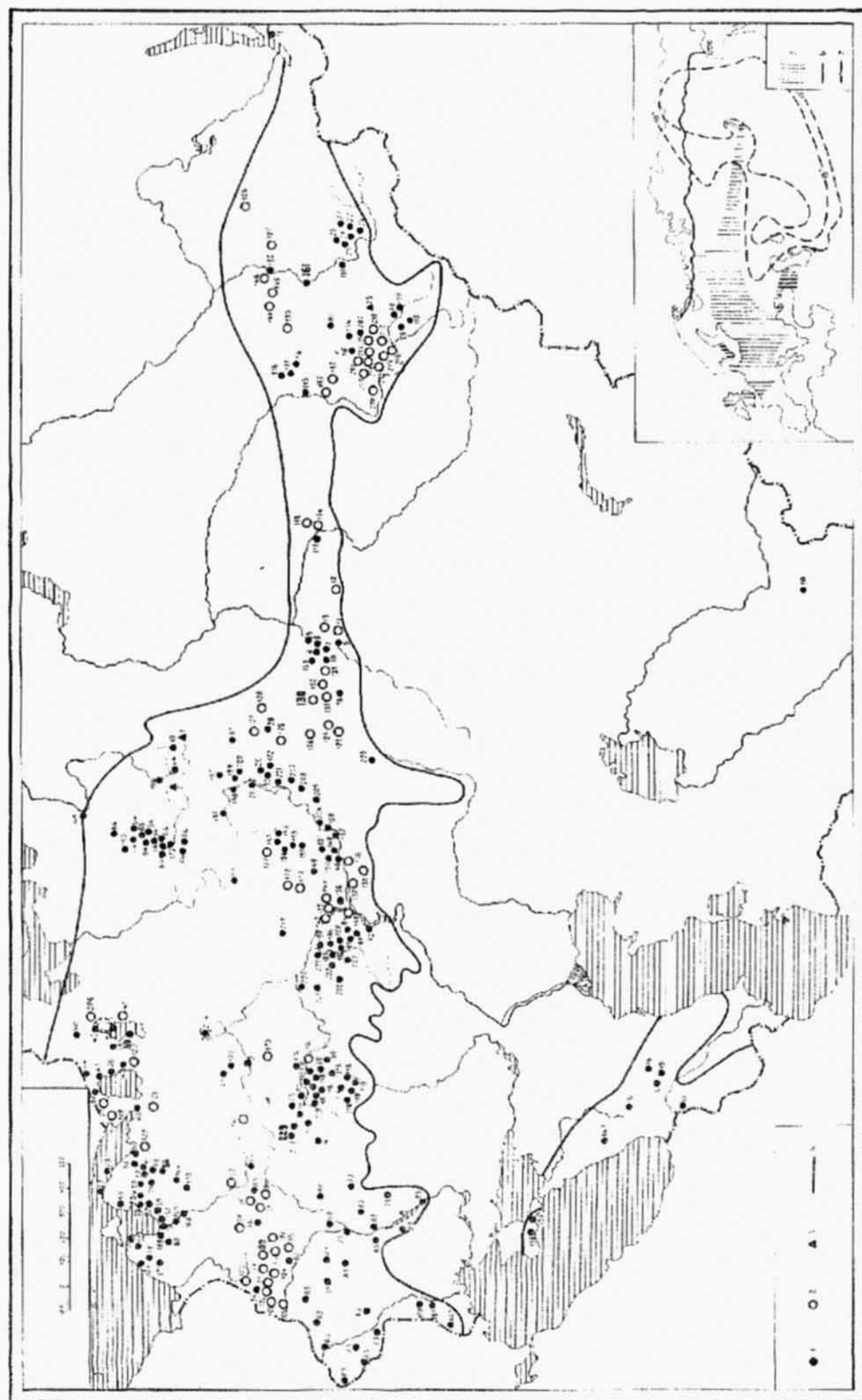


Fig. 1. Distribution of *Ixodes trianguliceps*. Legend: 1 - precise localities, 2 - district centres, 3 - upper reaches of rivers; 4 - supposed boundaries of the distribution area in the USSR; 5 - distribution of ticks of this species in Eurasia; 6 - isotherm of total sum of effective temperatures 1200°; 7 - isolines of indicators of continental climate degrees.

In the European part of the USSR the ticks *I. trianguliceps* have been found in the territory of the Karelian and Komi Autonomous SSR, in the Leningrad and Pskov regions, in the Baltic Republics (Estonia, Latvia and Lithuania), in the regions of Kalinin, Moscow, Kaluga, Ryazan, Kirov, Kuibyshev and Ulianovsk, in the Udmurt, Chuvash, Mari and the Tatar Autonomous SSR. The southernmost localities of this part of the distribution area are to be found within the boundaries of the forest regions of Moldavia, in the Ukrainian woodlands and in the regions of Kursk and Tula.

In the Urals the ticks *I. trianguliceps* are known in regions situated between latitudes 60° (Perm region) and 54° North (Sverdlovsk and Cheliabinsk regions).

In the Asiatic part of the USSR the ticks *I. trianguliceps* have been found in the territory of the Tiumen, Omsk, Tomsk, Kemerovo, Novosibirsk regions, in the Altai and in the southern part of the Krasnoyarsk territory.

In the Carpathians the ticks *I. trianguliceps* reach the altitude 2050 m (EMCHUK 1960), in the Caucasus mountains — the altitude 2300 m (DJAPARIDZE 1960), in the Altai — the altitude 1200 m (SAPEGINA 1967).

Our cadastre-reference map gives quite a good general idea about the distribution of the tick *I. trianguliceps*. However, there are no sufficient reasons for delineating the boundary line of the area along the extreme localities of their occurrence, so far as the vast territory, on which they may be later found, has been insufficiently investigated. We have tried to define the supposed boundary line of *I. trianguliceps* in the territory of the USSR, proceeding from definite natural conditions.

A comparison of our map with a map of effective temperatures above 0° has shown that in the territory of the USSR the ticks *I. trianguliceps* have not been found anywhere to the north from the isoline +1200°. The northern boundary line of *I. trianguliceps* distribution probably does not exceed the effective temperatures line from 1400 to 1200°. It has also become apparent that the ticks of this species have not been found to the east from the isoline 15° characterizing the degree of continental climate (IVANOV 1953). The eastern and southeastern boundary line of the distribution of these ticks may be to a certain extent associated with the indicators of continental climate corresponding with the isolines 10° and 15° (see map).

The vegetation map of the USSR has made it clear that most localities of the tick occurrence are situated within the dark-coniferous forrest of central and southern taiga, less often in the pine, broad-leaved and aspen-birch forests. The basic forest tree species in the forests where the ticks have been found, are *Picea excelsa* and *Abies sibirica*. Less abundant are *Pinus silvestris*, *Larix sibirica*, *Betula verrucosa*, *Populus tremula*, *Tilia cordata*.

From the foregoing considerations it may be presumed that the northern boundary line of the distribution area of *I. trianguliceps* in the European part of the USSR is running along the line dividing dark-coniferous forests of the northern taiga and central taiga and in some places penetrating into the southern massifs of the northern taiga forest. In the Urals this line is apparently concurrent with the northern fores

boundary, while in West Siberia it exists north of the line dividing the southern taiga and aspen-birch forests (see map). The shifting of the northern boundary line of the distribution area in West Siberia towards the south may be also connected with the presence of sphagnum bogs there. In the larch forests standing east of the river Yenisey the ticks *I. trianguliceps* have not been found, so that their distribution area confines itself to the expansion of the montane dark-coniferous forests.

The present southern boundary line of the distribution area of *I. trianguliceps* according to our assumptions must generally coincide with the boundary of the forest expansion. However, in the Tula region and in the Ukraine the ticks have also been discovered south of this line. Probably they can penetrate south through small forest patches and valleys of big rivers. In mountain regions the distribution of the ticks is also limited by the forest belt.

DISCUSSION

Within the boundaries of the USSR *I. trianguliceps* is to be found in the central and southern taiga, in broad-leaved-coniferous and broad-leaved forests, as well as in the forests of some mountain systems. Here and there the ticks of this species penetrate into the northern taiga and forest-steppe. The use of punched cards has made it possible to obtain a general idea about some peculiarities of the ecology of *I. trianguliceps* in different zones.

In the taiga and broad-leaved-coniferous forests these ticks inhabit mainly the zonal biotopes of watersheds. In the taiga they are most often to be found in spruce, mixed and secondary aspen-birch forests. Their number is considerably reduced in pine forests and felled areas. In the zone of broad-leaved-coniferous forests, as a rule, they live in spruce forests and are more rare in broad-leaved, pine and aspen-birch stands. They penetrate into the forest-steppe through flood areas of rivers, gullies with tree and shrub vegetation, and through low-level areas of relief with broad-leaved and aspen-birch forests.

Everywhere within the boundaries of the USSR the small terrestrial mammals are the main blood source of the ticks *I. trianguliceps*. The representatives of the genera *Clethrionomys*, *Sorex* and *Apodemus* are of greatest importance. In various zones, however, there are marked differences in the range of hosts of these ticks (see Table). They are very rarely found on goats (EMCHUK 1960).

The ticks are active the whole year round. A marked increase of their numbers usually occurs twice a year: in summer and in autumn. In the taiga zone it is observed in June—July and in September—October (VYSOTSKAYA 1951; NIKITINA 1960; MALYUSHINA, LOGINOVA 1963; BOBROVSKIY 1966). In the zone of the broad-leaved-coniferous and broad-leaved forests the first increase of the tick numbers is also observed in June—July, the second occurs later, in October—November (ARZAMASOV 1963; MIASNIKOV, KATELINA 1964).

A comparison of the tick abundance on their main hosts in various zones has

shown that in the central and southern taiga the mean index of *I. trianguliceps* abundance on voles of the genus *Clethrionomys* and shrews of the genus *Sorex* ranges between 0.3 and 1.5, the usual tick infestation being 15—30 % of animals. In other zones the numbers of ticks, as a rule, are much lower. They occur only on 5—10 % of animals and the abundance indices are not higher than 0.3—0.5.

CONCLUSION

The tick *I. trianguliceps* is widely distributed over the territory of the Soviet Union. The drawn up map does not confirm the existing view (MALYUSHINA 1966) that the distribution of these ticks coincides with the expansion of forests, in which *Tilia cordata* predominates or participates. The ticks penetrate considerably more to the east than *Tilia cordata*. In the European part of the USSR the tick *I. trianguliceps* in some northern places reaches the Polar Circle and is apparently one of the most "cold-resistant" species of the genus *Ixodes*. According to the range of maintenance hosts, the level of its numbers and peculiarities of biotopic distribution, most probably this tick is closely associated with dark-coniferous forests of the central and southern taiga.

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