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Review

A Review of Ixodid Ticks (Acari: Ixodidae) Associated with *Lacerta* spp. (Reptilia: Lacertidae) from the Caucasus and Adjacent Territory

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Abstract: Based on a literature review, as well as on our own data, 14 ixodid tick species belonging to 5 genera were registered for the lizard hosts of the genus *Lacerta* (*L. agilis*, *L. media*, and *L. strigata*) in the Caucasus and the adjacent territories: *Haemaphysalis sulcata*, *Haem. punctata*, *Haem. parva*, *Haem. caucasica*, *Haem. concinna*, *Haem. inermis*, *Ixodes ricinus*, *I. redikorzevi*, *Dermacentor marginatus*, *D. reticulatus*, *Hyalomma marginatum*, *Rhipicephalus bursa*, *Rh. rossicum*, and *Rh. turanicum*. Tick species *Haem. caucasica* were recorded from Armenia for the first time. Our findings of *Haem. punctata* represent the first record of this species for Chechnya, Ingushetia (Russia), Armenia, and Azerbaijan. Most of the parasite species are associated with *L. agilis* (13) and *L. strigata* (12); *L. media* is a host of 6 tick species. Data on the infestation of *Lacerta* spp. by four tick species from our material (*I. ricinus*, *Haem. punctata*, *Haem. caucasica*, and *Hyal. marginatum*) are presented in the article. In addition, our article contains information on the range of infections associated with the above tick species. Castor bean tick *I. ricinus* (236 specimens), the most represented species in our collection, parasitizes all available terrestrial vertebrates including humans and can be vector of many various pathogens, so our study provides significant epidemiological information.

Keywords: *Ixodes ricinus*; *Haemaphysalis punctata*; *Hyalomma marginatum*; *Haemaphysalis caucasica*; *Lacerta*; Caucasus

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1. Introduction

Parasitiform ticks and mites (Acari) are frequent ectoparasites of ecto- and endothermic terrestrial vertebrates. At least 242 species of Acari have been recorded as permanent parasites of reptiles [1], with hematophagic ticks (Ixodida) particularly common. Reptiles are even important reservoirs for tick-borne human pathogens, such as the spirochaete *Borrelia burgdorferi*, the cause of Lyme borreliosis [2,3], and hematophagic ticks are frequently found parasitizing lizards.

Ixodid or hard ticks (Acari: Ixodida: Ixodidae) are blood-feeding arthropods, with around 900 described species in 19 genera in three families, having a worldwide distribution and infesting virtually all terrestrial vertebrates. Ixodid ticks are capable of transmitting a broad range of human and animal pathogens. In the Palearctic region, the most well-represented genus is *Ixodes* (44 species), followed by *Haemaphysalis* (19 species), *Dermacentor* (13 species), *Rhipicephalus*, and *Hyalomma* (each with 7 species).

We chose three green lizard (genus *Lacerta* Linnaeus, 1758) species as objects of our study: three-lined lizard *L. media* Lantz et Cyrén, 1920, Caspian green lizard *L. strigata* Eichwald, 1831, and sand lizard *L. agilis* Linnaeus, 1758, since they are widespread in the Caucasus and one of the most common terrestrial vertebrates in the region. The parasite fauna of green lizards has been studied extremely unevenly. Information on the ectoparasites of *L. media* and *L. strigata* is fragmentary. At the same time, *L. agilis* Linnaeus, 1758 is one of the most complete and comprehensively studied reptile species in terms of parasitology. Extensive studies of this lizard have been carried out within the territory of the former Soviet Union and, above all, in its European part [4]. Information about parasites in other parts of the above territory is mostly fragmentary.

Green lizards are included in the regional and national lists of protected animal taxa. For example, the *Red Data Book of the Russian Federation* includes *L. agilis grusinica* Peters, 1960 (subspecies declining in numbers and/or distribution), *L. a. mzymtensis* Tuniyev S. et Tuniyev B., 2008 (endangered subspecies) and the Black Sea population of *L. media* Lantz et Cyren, 1920 (declining population and/or distribution) [5–7]. This underlines the relevance of this study from the perspective of studying and conserving biodiversity.

The issue of lizard species diagnostics also remains relevant. In particular, we noted numerous errors in the published articles and species distribution databases. Such oversights, if left uncorrected, may lead to errors in our collective understanding of parasite–host relationships and parasites' life cycle.

The aim of our article is to provide the first complete review of ixodid ticks (medically and veterinary significant species) parasitizing green lizards of the Caucasus and adjacent territories, forming one of the centers of their taxonomic diversity. We documented and curated previously published data including Russian-language non-digital (printed) sources, as well as previously unpublished records of ticks associated with lizards preserved at the Zoological Institute of the Russian Academy of Sciences (ZISP), which holds one of the largest collections of these animals in terms of diversity and specimen numbers. Also, we collected the most complete data on epidemiological significance of all tick species parasitizing lizard hosts under study.

2. Materials and Methods

Host specimens were collected in the Caucasian part of Russia, Armenia, Azerbaijan, Georgia (including Abkhazia), Turkey, Iran, and Iraq between 1871 and 2022, fixed in alcohol, and deposited at the ZISP. In 2021–2022, we carefully examined 1189 specimens belonging to three species of the genus *Lacerta*, including 814, 112, and 263 specimens of *L. agilis*, *L. media*, and *L. strigata*, respectively. Ticks were attached to their lizard hosts, so potential museum cross-contamination was excluded. Lizards of the genus *Lacerta* were determined according to a key by Bannikov et al. [8]. The morphological identification of ixodid ticks was performed based on a key by Estrada-Peña et al. [9]. Parasite specimens were mounted on permanent microscopic slides in Faure–Berlese's mounting medium. Specimens were examined under a compound microscope (AxioImager A2, Zeiss, Germany). Slide-mounted specimens were deposited at ZISP.

In this study, the prevalence and mean intensity of ticks were determined according to these definitions: Prevalence (P) is the number of host specimens infected by at least one tick divided by the number of specimens examined. Mean intensity (MI) is the total number of ticks of particular species divided by the number of specimens infected with ticks of those species. Indexes P and MI were calculated for each species (*I. ricinus*, *Haemaphysalis punctata*, *Haem. caucasica*, *Hyalomma marginatum*). Alphabet designations: L means larva; N means nymph.

3. Results

Ticks have been found on 94 host specimens (prevalence 7.9%). Total 389 ticks have been removed from lizards (mean intensity 4.1).

List of ticks associated with green lizards in Caucasus and adjacent territories is present below.

Family Ixodidae C.L. Koch, 1844;

Genus *Haemaphysalis* C.L. Koch, 1844;

Distribution of the genus: cosmopolitan [10].

Haemaphysalis sulcata Canestrini et Fanzago, 1878;

Distribution: Albania, Algeria, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France, Greece, Georgia, India, Iran, Italia, Libya, Northern Macedonia, Morocco, Romania, Saudi Arabia, Serbia, Slovenia, Southern Russia (Crimea, Dagestan), Spain, Tunisia, Turkey [10–17].

Green lizard hosts: *L. agilis*, *L. strigata* [11], *L. media* [17].

Other hosts: Reptiles and birds are hosts for immature ticks, while large mammals, including cattle and sheep, are the major hosts for adults of *Haem. sulcata* [17].

Pathogen transmission: *Babesia* sp. and *Theileria* sp. [18], *Anaplasma ovis* [15,19], *A. phagocytophilum* [20].

Haemaphysalis punctata Canestrini et Fanzago, 1878 (Figure 1).

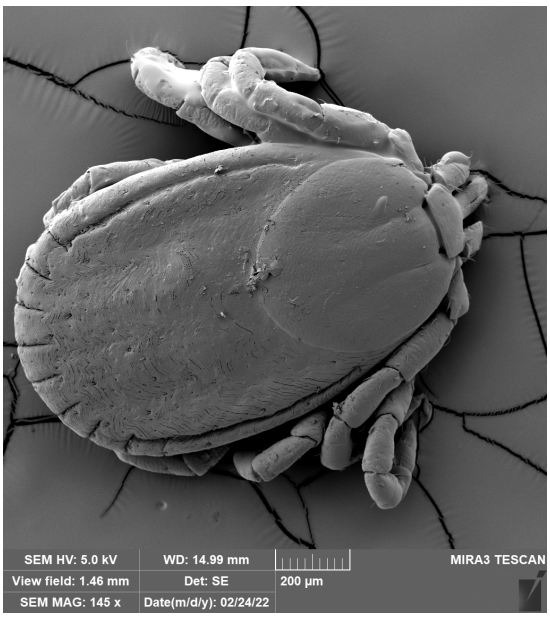

Figure 1. *Haemaphysalis punctata*, nymph ex *Lacerta strigata* (collection lot number ZISP 12660), photo by Nikolay V. Anisimov.

Material: 5L ex *L. strigata* from Russia, Chechnya, Sunzhensky District, Sernovodskoye (=Mikhailovskaya), 1886, leg. A.N. Ananov (collection lot number ZISP 7195); 3L ex *L. media* from Turkey, Artvin, Ardanuç, 25 VII 1898, leg. K.M. Derjugin (collection lot number ZISP 9085); L ex *L. strigata* from Georgia, Kakheti, Lagodekhi, 1901, leg. Vinogradov (collection lot number ZISP 9662); 35L ex *L. strigata* from Armenia, Gegharkunik Province, shore of Lake Sevan (=Gokcha), Shorja (=Shorzha, Nadezhdino), 1 VIII 1923, leg. V.V. Bogachev (collection lot number ZISP 12660); N ex *L. agilis* from Russia, Ingushetia, Dzheyrakhsky District, vicinity of the Ersh (=Ershna), Assa River, 3 IX 1929, leg. D.B. Krasovsky (collection lot number ZISP 13498); 2L ex *L. media* from Georgia, Adjara, Kedlebi, 16 VII 1958, leg. V.V. Petrov (collection lot number ZISP 18701); 14L ex *L. strigata* from Georgia, Tbilisi, Tbilisi Sea, 11 VII 1972, leg L.A. Eruch (collection lot number ZISP 18880); 14L ex *L. strigata* from Russia, North Ossetia–Alania, Kirovsky District, vicinity of Elkhotovo, road to Vladikavkaz (=Ordzhonikidze), left bank of the Terek River, VII 1973, leg. I.S. Darevsky (collection lot number ZISP 18600); 4L ex *L. agilis* from Russia, North Ossetia–Alania, Kirovsky District, vicinity of Kardzhin, 10 VII 1973, leg. V.I. Naniev (collection lot number ZISP 18607.3); 5N, 20L ex *L. agilis* from Russia, North Ossetia–Alania, Prigorodny District, Tarskaya

basin, 20 VII 1973, leg. V.I. Naniev (collection lot number ZISP 18622); 5N, 41L ex *L. media* from Georgia, Samtskhe–Javakheti, on the way from Vardzia monastery to Nakalakevi, 20 VII 1973, leg. I.S. Darevsky (collection lot number ZISP 18360); 14L ex *L. strigata* from Azerbaijan, Lankaran District, Bilyasar, 3 VI 1974, leg. I.S. Darevsky (collection lot number ZISP 18115.2); 3 L ex *L. strigata* from Azerbaijan, Tovuz District, gorge of the middle reaches of the Dzegam Chay River (=Dzegam-chay, Zayamchay), vicinity of Garibli (=Karibli), 23 VIII 1976, leg. I.S. Darevsky (collection lot numbers ZISP 18741.1 and 18741.2); N, 2L ex *L. strigata* from Azerbaijan, Gadabay District, vicinity of Bashkend (=Old Bashkend, Artsvashen), 24 VIII 1976, leg. I.S. Darevsky (collection lot number ZISP 18740).

Distribution: Albania, Algeria, Armenia (this study, new record), Azerbaijan (this study, new record), Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Egypt, France (including Corsica), Georgia, Great Britain, Greece, Hungary, Italy (including Sicily and Sardinia), Kosovo, Lebanon, Libya, Moldova, Morocco, Netherlands, Northern Macedonia, Poland, Portuguese, Romania, Russia (including Crimea), Serbia, Slovakia, Slovenia, Spain, Switzerland, Sweden (Gotland, Öland), Tunisia, Turkey, Ukraine [[9,21,22], this study].

Green lizard hosts: *L. agilis*, *L. strigata* [[11,23], this study], *L. media* [[24], this study].

Other hosts: Small mammals, hares, hedgehogs, birds are hosts of the immature stages, while adults mainly feed on wild and domestic ungulates, particularly cattle, sheep, and goats [25–29]. Other hosts for the adult ticks include domestic dogs, red foxes, mustelids, lagomorphs and hedgehogs [25,26,30], humans [25,26].

Pathogen transmission: *Babesia bigemina*, *B. major*, *B. motasi*, *Brucella* spp., *Rickettsia sibirica*, *R. helvetica*, *R. massiliae*, *R.* nr *hoogstraalii*, *R. monacensis*-like *Rickettsia*, *Anaplasma bovis*, *A. centrale*, *A. phagocytophilum*, *Coxiella burneti*, *Theileria* spp., *Borrelia burgdorferis*, *Francisella tularensis* [9].

Remark: our finding of *Haem. punctata* is the first record of this species for Chechnya and Ingushetia (Russia), Armenia, and Azerbaijan.

Haemaphysalis parva (Neumann, 1897)

Distribution: Azerbaijan, Georgia, Egypt, Iraq, Jordan, Lebanon, Libya, Macedonia, Palestine, Romania, Russia (Dagestan, Krasnodar, and Stavropol Krai), Syria, Turkey, and Turkmenia [9,22,23,31–38].

Green lizard hosts: *L. agilis* [23,39], *L. strigata* [11].

Other hosts: small mammals (hares, hedgehogs), birds, and lizards are hosts for immature stages; adults mainly feed on wild and domestic ungulates, particularly cattle, ships, and goats. *H. parva* can attack humans [9].

Pathogen transmission: *Babesia ovis*, *Coxiella burnetii* (the causative agent of Q fever), *Franciesella tularensis* [10], *Rickettsia hoogstraali* [40], Candidatus '*Rickettsia goldwasserii*' [41].

Haemaphysalis caucasica Olenev, 1928

Material: N ex *L. strigata* from Armenia, Gegharkunik Province, shore of Lake Sevan (=Gokcha), Shorja (=Shorzha, Nadezhdino), 1 VIII 1923, leg. V.V. Bogachev (collection lot number ZISP 12660); N ex *L. media* from Azerbaijan, Shamakhi District, vicinity of Kirovka (=Nagarakhana, Maryevka), 30 VI 1948, leg. A.M. Alekperov (collection lot number ZISP 30061).

Distribution: Armenia (this study, new record), Azerbaijan, Iran, Kyrgyzstan, Russia (Crimea, Dagestan), Tajikistan, Ukraine, Uzbekistan [[9,11,23], this study].

Green lizard hosts: *L. agilis* [11,23], *L. media*, *L. strigata* (this study, new record).

Other hosts: hares are the most common hosts of all life history stages, also occurs on bears, jackals and foxes. Nymphs can also feed on lizards [23].

Pathogen transmission: unknown.

Remark: *Haem. caucasica* has been recorded for Armenia for the first time.

Haemaphysalis concinna Koch, 1844

Distribution: Austria, Belarus, Bulgaria, China, Croatia, the Czech Republic, France, Germany, Hungary, Iran, Italy, Japan, Poland, Romania, Russia, Serbia, Slovakia, Spain, and Turkey [9].

Green lizard hosts: *L. agilis* [23]

Other hosts: the immatures feed on a wide variety of small and medium-sized mammals and birds [10,12,26,42–44]. Adults feed on wild and domestic ungulates, carnivores, such as foxes and dogs, and medium-sized insectivores, such as hedgehogs [10,12,26,42,43,45,46].

Pathogen transmission: Variety of *Rickettsia* spp., including *Rickettsia heilongjiangensis*, *Rickettsia sibirica* [47–49], *Rickettsia helvetica*, Candidatus "*Rickettsia rara*" and Candidatus "*Rickettsia kotlanii*" [46,50,51]. It is also a vector of *Anaplasma phagocytophilum*, *A. bovis*, *Coxiella burnetii* and *Francisella tularensis* [43,49,52–54], the tick-borne encephalitis virus (49,54], Crimean Congo haemorrhagic fever virus [55], Omsk haemorrhagic fever virus and Tamdy virus [56].

Haemaphysalis inermis Birula, 1895

Distribution: Albania, Austria, Bulgaria, Czech Republic, France, Greece, Hungary, Iran, Italy, Poland, Portugal, Romania, Slovakia, Spain and Turkey [57,58], Russia (Dagestan) [11].

Green lizard hosts: *L. agilis L. strigata* [11].

Other hosts: domestic and wild ungulates, small mammals, birds. These ticks can parasitize a range of mammals including cattle, horses, sheep, deer, dogs, foxes and hedgehogs. Human infestation has also been reported [12,16].

Pathogen transmission: putative vector of pathogens to humans (e.g., *Rickettsia aeschlimannii*, *Rickettsia helvetica*) [51,59], *Babesia bigemina* [60].

Genus *Ixodes* Latreille, 1795.

Distribution of the genus: cosmopolitan [10].

Ixodes ricinus Linnaeus, 1758 (Figure 2)

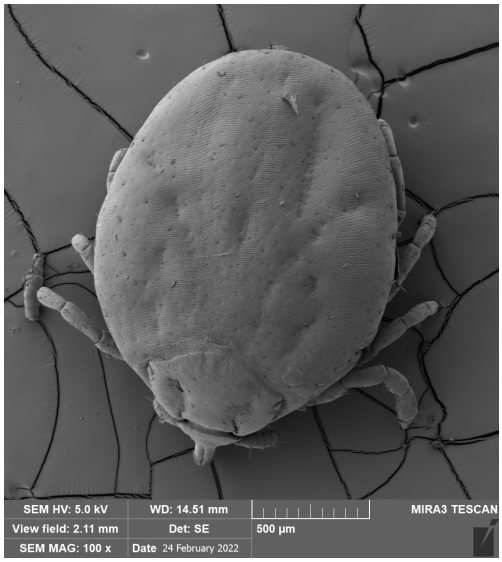

Figure 2. *Ixodes ricinus*, nymph ex *Lacerta strigata* (collection lot number ZISP 31555), photo by Nikolay V. Anisimov.

Material: 5L ex *L. agilis* from Russia, Adygea, Maykopsky District, Dakhovskaya, 18 VIII 1871, leg. M.N. Bogdanov (collection lot number ZISP 22903); N, 3L ex *L. agilis* from Russia, North Ossetia–Alania, Vladikavkaz city, 1886, leg. A.N. Ananov (collection lot number ZISP 7205); N, 23L ex *L. strigata* from Georgia, Kakheti, Lagodekhi, 1901, leg. Vinogradov (collection lot number ZISP 9662); 7N ex *L. agilis* from Krasnodar Krai, Sochi, Krasnaya Polyana, 1903, leg. A.A. Brauner (collection lot numbers ZISP 20670.21 and 20670.22); N ex *L. agilis* from Georgia, Adjara, Kobuleti, VIII 1909, leg. K.A. Satunin (collection lot number ZISP 12646); 2N ex *L. agilis* from Georgia (Abkhazia), Sukhumi (=Sukhum), 1879, leg. V.I. Chernyavsky (collection lot number ZISP 5281); N ex *L. strigata* from Azerbaijan, Yardimli District, Dyman (=Deman), 25 V 1909, leg. A.N. Kirichenko (collection lot number ZISP 12618); 2L ex *L. agilis* from Russia, Krasnodar Krai, Mostovsky District, Psebay

(=Psebayskaya), VII-IX 1909, leg. S.N. Romanov (collection lot number ZISP 12908); 3N ex *L. agilis* from Russia, Krasnodar Krai, Labinsky District, Labinsk (=Labinskaya), 1 V 1911, leg. D. Volnukhin (collection lot number ZISP 13043); N ex *L. agilis* from Russia, Krasnodar Krai, Mostovsky District, Psebay (=Psebayskaya), 13 V 1911, leg. D. Volnukhin (collection lot number ZISP 10906); 4N ex *L. agilis* from Georgia (Abkhazia), Gagra District, Salme (=Psou), IV. 1914, leg. S.F. Tzarevsky (collection lot number ZISP 11506); 2L ex *L. media* from Georgia, Samtskhe–Javakheti, Borjomi, 1915, leg. Vinogradov, Nikitin (collection lot number ZISP 12393); N ex *L. agilis* from Russia, Krasnodar Krai, Ust-Labinsky District, Aleksandrovsky, 10 VII 1926, leg. A.P. Heideman (collection lot number ZISP 12478); 2N ex *L. agilis* from Russia, North Ossetia–Alania, vicinity of the Vladikavkaz city, 10 V 1927, leg. N. Karashechev (collection lot number ZISP 15228); 3L ex *L. strigata* from Russia, Dagestan, Buynaksky District, vicinity of Buynaksk (=Temir-Khan-Shura), 12 VII 1928, leg. G.F. Sukhov, S.A. Chernov (collection lot number ZISP 12453); 7L ex *L. agilis* from Russia, Krasnodar Krai, Mostovsky District, Psebay (=Psebayskaya), 2 VII 1930, leg. A.N. Bartenef (collection lot numbers ZISP 14794.1 and 14794.2); 6N ex *L. agilis* from Armenia, Gegharkunik Province, an island on Lake Sevan opposite the of Yelenovka (=Sevan), 1–3 VII 1930, leg. G.F. Sukhov (collection lot numbers ZISP 12526, 12895 and 12896); L ex *L. agilis* from Russia, North Ossetia–Alania, Vladikavkaz, 14 VII 1930, G.F. Sukhov (collection lot number ZISP 12485); N ex *L. agilis* from Russia, Kabardino-Balkaria, Maisky District, Kotlyarevskaya, 19 VII 1930, leg. G.F. Sukhov (collection lot number ZISP 12484); 5N, L ex *L. agilis* from Russia, Adygea, Maykopsky District, Caucasus Nature Reserve, Guzeripl, 19 VI 1931, leg. unknown (collection lot numbers ZISP 16344.1 and 16344.2); 3L ex *L. agilis* from Russia, Adygea, Maykop District, Caucasus Nature Reserve, Kisha River, 1 IX 1934, leg. L.I. Khosatzky (collection lot number ZISP 15157); L ex *L. strigata* from Azerbaijan, Oguz District, Vartashen (=Oguz), 10 VIII 1950, leg. M.N. Meyer (collection lot number ZISP 16969); L ex *L. agilis* from Russia, Adygea, Maykop District, Caucasus Nature Reserve, Kisha River, 17–25 IX 1934, leg. A.I. Shchellova (collection lot number ZISP 16394); L ex *L. media* from Georgia, Adjara, Kedlebi, 16.07.1958, leg. V.V. Petrov (collection lot number ZISP 18701); 2N, L ex *L. agilis* from Georgia, Kvemo Kartli, near the Manglisi, 22 VI 1962, leg. I.S. Darevsky (collection lot number ZISP 17546); 3L ex *L. media* from Iran, North of Mazandaran, 1965, leg. M. Latifi (collection lot number ZISP 18006); 4N ex *L. agilis* from Russia, Krasnodar Krai, Sochi, vicinity of Babuk-Aul, 20 VIII 1967, leg. I.S. Darevsky (collection lot number ZISP 18066); 7N ex *L. agilis* from Russia, Krasnodar Krai, Sochi, Krasnaya Polyana, IV 1972, leg. G.O. Bogdanova (collection lot numbers ZISP 20670.21 and 20670.22); 2N, 9L ex *L. agilis* from Russia, Krasnodar Krai, Seversky District, Krepostnaya, 1972, leg. L. Kazakova (collection lot numbers ZISP 19543.1, 19543.2); N, 31L from *L. agilis* from Russia, Krasnodar Krai, Seversky District, Krepostnaya, 22–27 VI 1972, leg. L. Kazakova (collection lot numbers ZISP 19590.1, 19590.9, 19590.11, 19590.16, 19590.18, 19590.20); 3L ex *L. strigata* from Georgia, Tbilisi, Tbilisi Sea, 11 VII 1972, leg. Eruch (collection lot number ZISP 18880); N ex *L. agilis* from Russia, Chechnya, Shalinsky District, vicinity of Shali city, 11 VII 1973, leg. I.S. Darevsky (collection lot number ZISP 18364); 4L ex *L. media* from Armenia, Syunik Province, vicinity of David Bek (=David-bek), fortress ruins, 1 VII 1974, leg. I.S. Darevsky (collection lot number ZISP 18456); 2♀♀, L ex *L. strigata* from Azerbaijan, Lankaran District, vicinity of Lankaran, 1 VI 1974, leg. I.S. Darevsky (collection lot number ZISP 18458); 5N, 6L ex *L. strigata* from Azerbaijan, Goygol District, Zurnabad, 22 VI 1974, leg. I.S. Darevsky (collection lot number ZISP 18514); 15L ex *L. strigata* from Azerbaijan, Lankaran District, Bilyasar, 3 VI 1974, leg. I.S. Darevsky (collection lot numbers ZISP 18115.1 and 18115.2); L ex *L. strigata* from Azerbaijan, Tovuz District, gorge of the middle reaches of the River Dzegam Chay (=Dzegam-chay, Zayamchay) vicinity of Garibli (=Karibli), 23 VIII 1976, leg. I.S. Darevsky (collection lot number ZISP 18741.2); L ex *L. strigata* from Azerbaijan, Gadabay District, vicinity of Bashkend (=Old Bashkend, Artsvashen), 24 VIII 1976, leg. I.S. Darevsky (collection lot number ZISP 18740); 12L ex *L. media* from Azerbaijan, Gadabay District, road from Shaheran to Gadabay, 28 VIII 1976, leg. I.S. Darevsky (collection lot number ZISP 18744); 4L ex *L. agilis* from Russia, Krasnodar Krai, Tuapse District, Afanasievskiy Postik,

IX 1979, leg. Milovanova (collection lot number ZISP 18987); N, L ex *L. agilis* from Russia, Adygea, Maykop District, Nickel, 26 VI 2000, leg. D.A. Melnikov (collection lot number ZISP 22208); 4N, 3L ex *L. agilis* from Russia, Krasnodar Krai, Apsheron District, Mezmay, 23 VI 2001, leg. D.A. Melnikov (collection lot number ZISP 22207.1); 2L ex *L. agilis* from Russia, Stavropol Krai, Kochubey District, Strijament Mountain, 26–27 VI 2005, leg. K.D. Milto, K.Yu. Lotiev (collection lot number ZISP 23555); L ex *L. agilis* from Russia, Stavropol Krai, Pyatigorsk, Lysaya Mountain, 23 VII 2006, leg. I.V. Doronin (collection lot number ZISP 25756); 2L ex *L. agilis* from Russia, Stavropol Krai, Alexandrovsk District, vicinity of Kruglolesskoye, 4 VII 2010, leg. I.V. Doronin (collection lot number ZISP 25973); 3N, 3L ex *L. agilis* from Russia, Kabardino-Balkaria, Nalchik, vicinity of Kenzhe, 17 VIII 2011, leg. I.V. Doronin (collection lot number ZISP 26321); L ex *L. strigata* from Russia, Stavropol Krai, Kirovsky District, Staropavlovskaya, 14 V 2018, leg. I.V. Doronin, M.A. Doronina (collection lot number ZISP 29869); N, 8L ex *L. agilis*, Georgia, Mtskheta-Mtianeti, Tianeti, 19 V 2018, leg. I.V. Doronin, M.A. Doronina (collection lot number ZISP 29879); ♀ex *L. strigata* from Russia, Stavropol Krai, Sovetsky District, Otkaznenskoye reservoir, bank of the Kuma River, 3 VI 2021, leg. I.V. Doronin (collection lot number ZISP 31555); 2N ex *L. agilis* from Russia, Stavropol Krai, Pyatigorsk, date and leg. are unknown (collection lot number ZISP 16917); N ex *L. media* from Armenia, Vayots Dzor Province, vicinity of Hors, 25 V 2022, leg. K.D. Milto (collection lot number ZISP TS 3031).

Distribution: Southern Scandinavia to the Mediterranean Sea, European Russia, Caucasus, Northern Africa [[10,61], this study].

Green lizard hosts: *L. agilis*, *L. strigata* [62], *L. media* [24].

Other hosts: larvae and nymphs feed on insectivores (hedgehogs, moles, shrews), rodents (squirrels, dormouse, black rats, gray rats, house mouse), birds (*Accipiter nisus*, *Lyrurus tetrix*, *Tetrao urogallus*, *Tetrastes bonasia*, *Capella gallinago*), rarely, reptiles (*Testudo graeca*, *L. strigata*, *Natrix natrix*, *Vipera ursini*, *Pseudopus apodus,* and others); adults feed on larger mammals, such as foxes, lynxes, horses, wild boars, roe deer, red deer, sika deer, domestic sheep, domestic goats, European mouflons. All three active stages feed on hedgehogs and hares. *I. ricinus* can attack humans [9,63].

Pathogen transmission: *Borrelia burgdorferi* s. l. (Lyme borreliosis), *Anaplasma phagocytophilum* (human granulocytic anaplasmosis), *Francisella tularensis* (tularaemia), *Rickettsia helvetica* and *Rickettsia monacensis* (spotted fever rickettsiosis), *Babesia divergens*, *B. microti* and *Babesia* (*Francaiella*) *caucasica* (babesiosis) [64], *Neoehrlichia mikurensis* (neoehrlichiosis), tick-borne encephalitis virus (encephalitis), Louping ill virus (encephalitis), and Tribec virus (encephalitis) [9].

Ixodes redikorzevi Olenev, 1927

Distribution: Southeast Europe, Anterior and Central Asia [10].

Green lizard hosts: *L. agilis* [10], *L. strigata* [65].

Other hosts: Larvae, nymphs and females feed on many rodents (*Cricetulus migratorius*, *Microtus* spp., *Apodemus* spp., *Meriones* spp., *Sciurus* spp., *Citellus pygmaeus*, *Marmota bobak*, *Spalax* spp.), insectivores (hedgehogs, shrews) and other mammals (*Lepus europaeus*, *Mustela* spp., *Vormela peregusna*, *Martes martes*, *Meles meles*, *Vulpes vulpes*), birds (*Alectoris kakelik*, *Columba livia*, *Galerida cristata*, *Emberiza* spp., *Oenanthe* spp., *Frithacus rubecula*, *Anthus* spp., *Mergus serrator*, *Phyloscopus* spp., *Pica pica*) [10].

Pathogen transmission: *Francisella tularensis* [66], *Coxiella burnetii* [67].

Genus *Dermacentor* Koch, 1844

Distribution of the genus: the Holarctic, Ethiopian, and Indo-Malayan zoogeographic regions [10].

Dermacentor marginatus (Sulzer, 1776)

Distribution: Austria, Azerbaijan, Balkans, Belarus, Czech Republic, France, Greece, Germany, Hungary, Italy, Lebanon, Poland, Portugal, Romania, Russia, Spain, Switzerland, Slovakia, Turkey, Ukraine [9,22].

Green lizard hosts: *L. agilis* [23], *L. strigata* [11].

Other hosts: preferred hosts of larvae are rodents and small-to-medium-size insectivores (shrews, moles and hedgehogs), as well as lagomorphs and carnivores, including dogs. The most important hosts of nymphs, in addition to those of larvae, are artiodactyls [68]. Adult females can be found on ungulates, carnivores (but rarely on pet dogs, [45]) and medium-sized insectivores [68]. Adults also feed on humans [69]. *Dermacentor marginatus* developmental stages have seldom been reported from bats [70] and birds [71].

Pathogen transmission: *D. marginatus* is a competent vector of tick-borne encephalitis virus, Crimean–Congo haemorrhagic fever virus, Omsk haemorrhagic fever virus, *Rickettsia sibirica*, *R. slovaca* (the more frequent causative agent of tick-borne lymphadenopathy (TIBOLA) in humans [72], *R. conorii*, *Babesia caballi* and *Theileria equi* [68]. In addition, the following pathogens have been found in this tick species: West Nile virus [73], *Coxiella burnetii* [74], *R. raoultii* [75], *R. massiliae*, *Ehrlichia canis*, and *Borrelia afzelii* [76].

Dermacentor reticulatus (Fabricius, 1794)

Distribution: Austria, Belarus, the northern Balkans (Croatia, Serbia, Romania, Bulgaria and Moldova), Belgium, the Czech Republic, France, Germany, Hungary, Northern Italy, Latvia, Lithuania, the Netherlands, Portugal and Spain (excluding Mediterranean regions), Poland, Russia (Dagestan), Slovakia, Switzerland, Slovenia, Ukraine, and United Kingdom [9].

Green lizard hosts: *L. agilis*, *L. strigata* [11].

Other hosts: preferred hosts of larvae include rodents and small-to-medium-size insectivores (shrews, moles, hedgehogs), as well as lagomorphs. Nymphs may also feed on artiodactyls and carnivores [68], including dogs [76]. Adult females can be found on ungulates, carnivores (especially dogs) and medium-sized insectivores and lagomorphs [68]. Adults also feed on humans [69]. *Dermacentor reticulatus* developmental stages have rarely been reported from bats [77], birds [68,78].

Pathogen transmission: Tick-borne encephalitis and Omsk haemorrhagic fever viruses, *Rickettsia sibirica*, *R. raoultii* (causing TIBOLA in humans), *R. conorii*, *Francisella tularensis*, *Anaplasma marginale*, *Babesia canis*, *B. caballi* and *Theileria equi* [68,79]. In addition, the following pathogens have been found in this tick species: *Coxiella burnetii* [74], *Bartonella* spp. [80], *Rickettsia helvetica* [81], *R. slovaca* [75], *Borrelia burgdorferi* s.l. [82], *Anaplasma phagocytophilum* and *Babesia microti* [79].

Hyalomma Koch, 1844

Distribution of the genus: Palaearctic, Indo-Malaysian and Afrotropical regions [10].

Hyalomma marginatum Koch, 1844 (Figure 3)

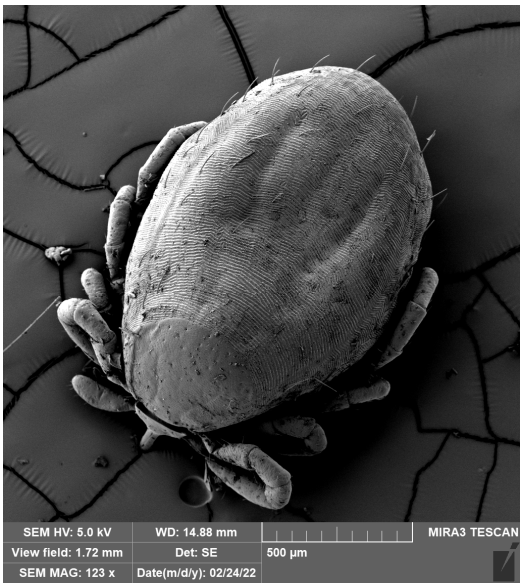

Figure 3. *Hyalomma marginatum*, nymph ex *Lacerta media* (collection lot number ZISP 22570), photo by Nikolay V. Anisimov.

Material: 8L ex *L. media* from Russia, Krasnodar Krai, Novorossiysk, Abrau-Durso, 10 V 1908, leg. Z.A. Mokrzecki (collection lot number ZISP 12614); L ex *L. strigata* from Azerbaijan (?) southwestern part of the Caspian Sea off the coast of the Caucasus, 1911, leg. N. Petrov (collection lot number ZISP 10957); 3L ex *L. media* from Georgia (Abkhazia), Gagra District, Gagra, VI 1911, leg. S.F. Tzarevsky (collection lot number ZISP 22914); ♀, 2L ex *L. media* from Russia, Krasnodar Krai, Novorossiysk, vicinity of Myskhako, VII 2002, leg. A. Petrov, A. Nikiforov (collection lot number ZISP 22570); 4L ex *L. media* from Azerbaijan, Yevlakh District, Khanabad, 20 km north of Yevlakh, 8 VI 1946, leg. N.K. Vereshchagin (collection lot number ZISP 15798); 19L ex *L. media* from Iran, West Azerbaijan province, Mount Sitover (=Sitow), 05 VI 1916, members of the Urmia expedition (collection lot number ZISP 12400); 4L ex *L. media* from Iraq, Kurdistan, Siya Güvez, 21 VI 1914, leg. P.V. Nesterov (collection lot number ZISP 11435); 2 L ex *L. media* from Iraq, Kurdistan, Kaniresh, (=Kani Rash), 12 VII 2014, leg. P.V. Nesterov (collection lot number ZISP 11437); 6L ex *L. media* from Iraq, Kurdistan, Khaks, 27 VII 1914, leg. P.V. Nesterov (collection lot number ZISP 11439); 3 L ex *L. media* from Iraq, Kurdistan, Vezne, 16 VII 1914, leg. P.V. Nesterov (collection lot number ZISP 11438); N, 5L ex *L. media* from Iran, Kurdistan, 35 km southwest of the Sekkes, vicinity of the Sekkes–Bane highway, 08 VIII 2018, leg. A.N. Barabanov (collection lot number ZISP 29894); 3 L ex *L. agilis* from Krasnodar Krai, Sochi, Adler, State Farm named after the 3rd International, the collection is not dated, but it should be attributed to the late 1920s–early 1930s. (probably 1930), leg. A.N. Bartenef (collection lot number ZISP 14795); 5L ex *L. agilis* from Georgia (Abkhazia), vicinity of Sukhumi (=Sukhum), 26 VI 1930, leg. S.A. Chernov (collection lot number ZISP 12378); N ex *L. agilis* from Georgia (Abkhazia), Sukhumi (=Sukhum), 1879, leg. V.I. Chernyavsky (collection lot number ZISP 5282).

Distribution: Albania, Algeria, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Egypt, France, Georgia, Greece, Iran, Iraq, Israel, Italy, Kosovo, Libya, Republic of Macedonia, Moldova, Montenegro, Morocco, Portugal, Romania, Russia, Serbia, Spain, Syria, Tunisia, Turkey, Turkmenistan, and Ukraine [12,83].

Green lizard hosts: *L. agilis* [[84], this study], *L. strigata* [[23], this study], and *L. media* [[21], this study].

Other hosts: adults feed on a wide variety of mammals, mainly wild and domestic ungulates, particularly bovines [12,85–87]. The larvae and nymphs are specific to small mammals (leporids and insectivores) and to ground-dwelling birds of various taxonomic groups [87]. This tick is often reported as biting humans [88–90].

Pathogen transmission: Crimean–Congo hemorrhagic fever virus [86,91], West Nile virus (under laboratory conditions) [92], *Anaplasma marginale* [93], *A. phagocytophylum* [94], *Babesia bigemina*, *B. bovis* [95], *B. caballi* [15], *B. occultans* [96], *Borrelia lusitaniae* [97], *Coxiella burnetii* [98], Dhori virus [99], *Rickettsia aeschlimannii* [100], *Theileria annulata* [101], *T. equi* [95] and *T. orientalis/sergenti/buffeli* group [96].

Genus *Rhipicephalus* Koch, 1844

Distribution of the genus: cosmopolitan [29].

Rhipicephalus bursa Canestrini et Fanzago, 1878

Distribution: Mediterranean Region (Southern Europe, North Africa and the Middle East), the Ukraine, Azerbaijan, Georgia, Iran, Kazakhstan, Russia, Turkmenistan and Uzbekistan [10,12,102].

Green lizard hosts: *L. agilis* [11,23].

Other hosts: all developmental stages feed on sheep, goats, cattle, horses, donkeys and rarely wild ungulates, although the preferred hosts are sheep and goats. Occasionally, it can be found on dogs, hares and birds [12]. Human infestations have also been reported [16,103].

Pathogen transmission: *Rh. bursa* is the main biological vector of *Babesia ovis* (ovine babesiosis) and plays an important role in the transmission of *Anaplasma ovis*, *A. marginale*, and *A. centrale* [104]. Several *Rickettsia* species (*R. aeshlimannii*, *R. conorii*, *R. felis*, *R. massiliae*, and *R. sibirica*) [105,106] and *Theileria ovis* [107] have been found in *Rh. bursa*. The AP92

strain of the Crimean–Congo haemorrhagic fever virus [108] was isolated from *Rh. bursa* collected from goats, but the vectorial capacity of this tick still needs to be proven.

Rhipicephalus rossicus Yakimov et Kol-Yakimova, 1911

Distribution: Armenia, Azerbaijan, Bulgaria, China, Egypt, Georgia, Iran, Israel, Kazakhstan, Tajikistan, Moldavia, Poland, Romania, Russia, Turkey, Ukraine, and Uzbekistan [109].

Green lizard hosts: *L. agilis*, *L. strigata* [11,23].

Other hosts: all stages feed on a large variety of hosts. At least nine families of birds and 17 families of mammals have been reported as hosts [109]. Amphibians and reptiles are exceptionally rare hosts [10]. There seems to be no differences in host preference between adults and the immature stages. This tick has been reported on humans several times [109].

Pathogen transmission: experimental proof for the vectorial capacity of *Rh. rossicus* is available for *Francisella tularensis*, Crimean–Congo hemorrhagic fever virus, and West Nile virus (for a complete review, see Mihalca et al. [109]). Other pathogens have been detected in *Rh. rossicus* by various laboratory methods, but there is no experimental evidence for its vectorial ability. These include: *Theileria equi*, *Babesia bigemina,* and *Coxiella burnetii* [109].

Rhipicephalus turanicus Pomerantzev, 1940

Distribution: Palearctic. Many records of *Rh. turanicus* from around the world are currently only speculative. It is heavily suspected that what has been classically described as "*Rh. turanicus*" in Europe west to Turkey might, in fact, represent another entity. It is important to note that molecular sequences available in GenBank are expected to have the same degree of unreliability as mentioned for the records or the knowledge of the ecology of this species.

Green lizard hosts: *L. agilis* [11], *L. strigata* [23].

Other hosts: this species feeds on mammals (e.g., rodents, lagomorphs, canids, felids and mustelids), birds [10,110,111]. Human infestation has been reported [10].

Pathogen transmission: since the taxonomic status of *Rh. turanicus* is under discussion, its role as a vector of human pathogens, including *Rickettsia massiliae*, *R. conorii,* and other microorganisms molecularly detected in ticks designated as this species, needs confirmation.

4. Discussion

Fourteen ixodid tick species belonging to 5 genera (Table 1) parasitize lizards of the genus *Lacerta* in the Caucasus and the adjacent countries: 6 species of the genus *Haemaphysalis*, 3 species of *Rhipicephalus*, 2 species of the genus *Ixodes*, 2 species of the genus *Dermacentor*, 1 species of the genus *Hyalomma*. Most of the findings belong to the following 3 species (Table 2): *I. ricinus* (the vast majority of findings), *Haem. punctata*, and *Hyalomma marginatum*. Some of our findings are the first records for the countries. In particular, *Haem. punctata* has been recorded from both Armenia and Azerbaijan for the first time. *Haem. caucasica* also has been recorded from Armenia for the first time. Our findings are represented mostly by immature stages (larvae and nymphs).

We can conclude that in the studied territory, 13 tick species (*I. ricinus*, *Haemaphysalis punctata*, *Haem. sulcata*, *Haem. parva*, *Haem. inermis*, *Haem. caucasica*, *Haem. concinna*, *Dermacentor marginatus*, *D. reticulatus*, *Rhipicephalus bursa*, *Rh. rossicus*, *Rh. turanicus*, *Hyalomma marginatum*) have been registered for *L. agilis*, 6 species (*I. ricinus*, *Haem. punctata*, *Haem. sulcata*, *Haem. caucasica*, *D. marginatus*, *H. marginatum*) have been associated with *L. media*, and 12 species (*I. ricinus*, *I. redikorzevi*, *Haem. sulcata*, *Haem. parva*, *Haem. punctata*, *Haem. inermis*, *D. marginatus*, *D. reticulatus*, *Rh. bursa*, *Rh. rossicus*, *Rh. turanicus*, *H. marginatum*) have parasitized *L. strigata*. *Haem. punctata* is characterized by the highest MI index, while the highest prevalence is observed in *I. ricinus*. The infestation by ticks of host species also differs: *L. media* demonstrates the highest infestation by *H. marginatum* (Table 2). Presumably, this difference may be associated with a different origin and ecology of these host species.

Table 1. Findings of ixodid ticks on *Lacerta* spp. in the Caucasus and adjacent territories (our findings are highlighted in bold).

Country	Region	Host		
		L. agilis	***L. media***	***L. strigata***
Russia	Stavropol Krai	*Ixodes ricinus* *Haemaphysalis punctata* *Haem. sulcata* [84,112,113] *Haem. parva* [[112], as *Haem. otophila*—[4,84]] *Hyalomma marginatum* [[112], as *H. plumbeum*—[4,84]]	-	***Ixodes ricinus* [[84,112], this study]** *Hyaloma marginatum* [as *H. plumbeum*—[113]]
	Krasnodar Krai	***Ixodes ricinus* [[39,114,115], this study]** *Haem. sulcata* [39,115] *Haem. parva* [as *Haem. otophila*—[39]] *Haemaphysalis* sp. [39,115]	-	-
	Adygea	***Ixodes ricinus* [[115], this study]** *Haemaphysalis* sp. [116]	-	-
	Kabardino-Balkaria	***Ixodes ricinus* [[62], this study]**	-	*Ixodes ricinus* [62]
	North Ossetia–Alania	***Ixodes ricinus* [[117], this study]** ***Haemaphysalis punctata* [this study]**	-	***Haemaphysalis punctata* [this study]**
	Ingushetia	***Haemaphysalis punctata* [this study]**	-	-
	Chechen	-	-	***Haemaphysalis punctata* [this study]**
	Dagestan	***Ixodes ricinus* [[4,24], this study]** *Haemaphysalis sulcata* *Haem. parva* [as *Haem. otophila*] *Haem. punctata* *Haem. inermis* *Haem. caucasica* *Dermacentor marginatus* *D. reticulatus* [as *D. pictus*] *Rhipicephalus bursa* *Rh. rossicus* *Rh. turanicus* *Hyalomma marginatum* [11] *Hyalomma* sp. [116]	*Haemaphysalis punctata* [24]	***Ixodes ricinus* [[24], this study]** *Haemaphysalis sulcata* *Haem. parva* [as *Haem. otophila*] *Haem. punctata* *Haem. inermis* *Dermacentor marginatus* *D. reticulatus* [as *D. pictus*] *Rhipicephalus bursa* *Rh. rossicus* *Rh. turanicus* *Hyalomma marginatum* [11] ** *Hyalomma* sp. [116]
	Georgia	*Ixodes ricinus* [this study]	***Ixodes ricinus* [this study]** ***Haemaphysalis punctata* [[21], this study]** *Hyalomma marginatum* [as *H. plumbeum*—[21]]	***Ixodes ricinus* [[118], this study]** *Haemaphisalis sulcata* [119] ***Haem. punctata* [this study]** *Rhipicephalus turanicus* [120]

Table 1. *Cont.*

Country	Region	Host		
		L. agilis	***L. media***	***L. strigata***
Armenia		Ixodidae [121]	Ixodidae [121]	Ixodidae [121] ***Haemaphysalis punctata*** **[this study, new record]** ***Haem. caucasica*** **[this study, new record]**
Azerbaijan		*Hyalomma* sp. [122] *	***Ixodes ricinus*** **[this study]** *Haemaphisalis sulcata* ***Haem. caucasica*** **[[123], this study]** *Dermacentor marginatus* *Hyalomma* sp. [123]	***Ixodes ricinus*** **[this study]** *I. redikorzevi* *Haemaphysalis sulcata* [65] ***Haem. punctata*** **[this study, new record]** *Hyalomma* sp. [122]
Turkey		-	*Ixodes ricinus* [124,125] *Haemaphysalis sulcata* [17] ***Haem. punctata*** **[this study]**	-
Iran		-	***Ixodes ricinus*** **[[23], this study]** ***Hyalomma marginatum*** **[this study]**	-
Iraq		-	***Hyalomma marginatum*** **[this study]**	-
The Caucasus (without locality)		*Haem. concinna* [23]	-	*Ixodes ricinus* *Haemaphysalis punctata* *Haem. sulcata* *Haem. inermis* [23] *Haemaphysalis* sp. [126] *Rhipicephalus turanicum* *Hyalomma marginatum* [as *H. plumbeum*—[23]]

*—most likely misidentification of the host species. **—in the original, the author indicated *Lacerta viridis* as the host species.

Table 2. Infestation of species belonging to *Lacerta* spp. by hard ticks in the Caucasus and adjacent territories (own data). Indexes P and MI were calculated for each species of hosts and ticks. In each cell, the first figure is MI—mean intensity, the total number of ticks of particular species divided by the number of specimens infected with ticks of those species; the second figure is P—prevalence, the number of host specimens infected by at least one tick divided by the number of specimens examined, %.

Parasite / **Host**	***L. agilis*** **n = 814**	***L. media*** **n = 112**	***L. strigata*** **n = 263**	**Total n = 1189**
I. ricinus	3.2; 5.5	4.4; 4.5	5.6; 4.6	3.7; 6.6
Haem. punctata	16.3; 0.5	24.0; 1.8	9.9; 3.4	13.5; 1.3
Haem. caucasica	-	1; 0.9	1; 0.4	1; 0.2
H. marginatum	3.0; 0.5	5.9; 8.9	1; 0.8	4.6; 1.4
Total	3.5; 6.6	7.9; 17.0	8.1; 8.7	4.1; 7.9

Total infestation of sand lizards by all ixodid tick species in our material is much lower than that in the data on Dagestan (P 6.6 vs. P 36.5) [11] and Poland (P 6.6 vs. P 13.8–58.1) [127]. It is difficult to explain the reason for the low infestation of lizards in our material; it is possible that ticks left their hosts during transportation, and in some cases, the acquired individuals were kept in captivity for some time, which also led to the loss of some of the ticks.

Analyzing the ecological niches of ticks (Table 3) and their hosts, it should be noted that the territory of the Caucasus has a high degree of mosaic landscapes. Probably, this explains the findings of ticks with different ecological niches on the same host species. In particular, the medium lizards, which prefers dry biotopes [128,129], can be the host of preferring-humidity *I. ricinus*. With the exception of *I. ricinus*, the rest tick species of the medium lizard are either inhabitants of dry biotopes (*Haem. caucasica*, *Haem. sulcate*, *D. marginatus*, *H. marginatum*) or are widespread species (*Haem. punctata*). Both sand lizard and Caspian green lizard harbor tick species preferring humid inhabitance (*I. ricinus*, *Haem. inermis*, *Haem. Parva D. reticulatus*), preferring arid inhabitance (*Haem. Caucasica*, *Haem. Caucasica*, *Haem. Sulcate*, *D. marginatus*, *Rh. Bursa*, *Rh. turanicus*), and inhabiting biotopes with different humidity (*Haem. punctate*, *H. marginatum*, *Rh. rossicus*).

Table 3. Infestation ecological niches of studied ticks.

Tick species	Landscape	Humidity	Literary Source
Ixodes ricinus	Commonly found in deciduous and coniferous woodland and mixed forests.	Requires a relative humidity of at least 80% to survive during its off-host period, being therefore restricted to areas of moderate-to-high rainfall with vegetation that retains a high humidity.	[23]
Ix. redikorzevi	Steppe biotopes.	Prefers dry habitats.	[23]
Haemaphysalis punctata	A wide variety of habitats from cold to mild. It inhabits pastures, forest margins, forest steppes, brush areas, limestone pastures, artificial conifer forests, oak forests with scarce undercover and, rarely, even evergreen oak forests.	It can be found in a very wide variety of habitats from humid climates to drier biotopes.	[15]
Haem. caucasica	This is a rare species. It occurs in steppe areas, either on the plains or more commonly in foothills and mountainous regions.	Prefers dry habitats.	[10]
Haem. concinna	It can occur in a variety of different habitats, including deciduous forests, mixed forests, mixed hornbeam–oak forests with bush undergrowth, forest clearings and the margin of oak forests, lake coasts, river basins, and in shoreline vegetation.	Prefers humid habitats.	[26]
Haem. sulcata	It occurs mostly in steppe with a semi-desert character and is usually not present in areas with high humidity. It is widespread mostly in wormwood foothills, mountain steppe, dry steppe, and semi-desert habitats. It has been recorded in mountain valleys up to 2200–2500 m a.s.l.	It is usually absent in areas with high humidity.	[12]
Haem. inermis	Generally found in temperate broadleaf and mixed forests.	Prefers humid habitats.	[29]

Table 3. *Cont.*

Tick species	Landscape	Humidity	Literary Source
Haem. parva	Various types of mountain steppe and lower mountain forest habitat. It is mostly observed around places with grazing livestock within altitudes of 0–1250 m a.s.l.	Prefers humid habitats.	[12]
Hyalomma marginatum	It has a Palearctic distribution showing ecological plasticity. It is adapted to several biogeographical regions supporting an extensive range of abiotic conditions.	From humid Mediterranean climates to the arid environments of steppe regions.	[128]
Dermacentor marginatus	Typical open country tick species, preferring meadows and pastures, where it may be sympatric with *D. reticulatus*.	Prefers dry habitats in xerophilic plant communities.	[68]
D. reticulatus	Typical open country tick species, preferring meadows and pastures. Frequently found in river basins or along lake shores. *Dermacentor reticulatus* occurs up to 1000 m a.s.l.	Prefers humid habitats.	[58,68]
Rhipicephalus bursa	It is closely associated with sheep breeding and is distributed mostly in areas with a humid winter and long dry summer. It can be found at altitudes up to 1950 m a.s.l.	Prefers dry habitats.	[10]
Rh. rossicus	Habitat preference is attributed mainly to host abundance and availability rather than to abiotic factors. The tick has been found at various altitudes, ranging from 0 to 1500 m a.s.l.	Prefers several habitats (from river basin valleys to dry forests and xeric shrublands from steppic regions).	[29,109]
Rh. turanicus	It prefers grasslands and pastures.	Prefers dry habitats.	[23]

Our study demonstrates the need for parasitological surveys of herpetological collections, which could undoubtedly provide interesting data on the diversity, distribution, and vector role of ectoparasites. Further molecular studies of the collected material are needed to investigate the spectrum of pathogens associated with ixodid ticks in the Caucasus region.

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