

Review articles

A biological/medical review of alien tick species (Acari: Ixodida) accidentally transferred to Poland

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ABSTRACT. Alien tick species of the genera *Ixodes, Amblyomma, Hyalomma* and *Rhipicephalus* are sporadically transferred to the territories of the Central European countries. A biological-medical review of the following alien tick species transferred to Poland is presented: *Ixodes eldaricus*, *Ixodes festai*, *Amblyomma sphenodonti*, *Amblyomma exornatum*, *Amblyomma flavomaculatum*, *Amblyomma latum*, *Amblyomma nuttalli*, *Amblyomma quadricavum*, *Amblyomma transversale*, *Amblyomma varanense*, *Hyalomma aegyptium*, *Hyalomma marginatum*, *Rhipicephalus rossicus* and *Rhipicephalus sanguineus.* The transfers of tick species out of the areas of natural distribution are divided into natural transfers (e.g., migration of ticks on hosts) and accidental transfers (e.g., resulting from the transport of livestock animals, trade in exotic animals, and transfers on animals during travel). It is important to monitor occurrence of unknown tick species on hosts in Poland.

Key words: ticks, *Ixodes*, *Amblyomma*, *Hyalomma*, *Rhipicephalus*, Poland

Alien tick species (Acari: Ixodida) accidentally transferred to Poland are species whose natural ranges and long-term sustained population habitats are situated in areas near Central Europe, in southern Europe near the Mediterranean and Black seas, or even further e.g., in Africa.

Transfers outside the natural ranges of tick species are divided into natural and accidental transfers [1]. The most frequent route of natural transfers involves the migration of ticks on their hosts e.g., migratory birds or mammals [2]. Transfers via artificial routes principally concern cases associated with the movement of tourists travelling with their pets, or the transportation of stock animals as well as with increasingly more numerous cases of importing exotic vertebrate species intended for private rearing [3,4].

Such cases were sporadically recorded in Poland and neighbouring countries and one can expect more of them. It is, however, debatable whether they create a potential risk for the tick populations developing in such new biotopes. Nevertheless, there is the possibility that transmissible diseases could be passed on to vulnerable local fauna or to humans. The future consequence of an invasion by tick species of alien origin could involve parasitological and epidemiological risks to human health, as well as having a harmful effect on the economy. As the long-heralded process of climatic change [5] results in the gradual increase in temperature, habitats previously unsuitable for ticks could become favourable and optimal for their development [6,7].

A systematic list of tick species transferred to Poland

Family: Ixodidae Murray, 1877
Subfamily: Ixodinae
Genus: ***Ixodes*** Latreille, 1795
Ixodes eldaricus Djaparidze, 1950
Ixodes festai Rondelli, 1926
Family: Amblyommidae Banks, 1907
Subfamily: Amblyomminae Banks, 1907
Genus: ***Amblyomma*** Koch, 1844
Amblyomma sphenodonti Dumbleton, 1943
Amblyomma exornatum (Koch, 1844)

Amblyomma flavomaculatum (Lucas, 1846)
Amblyomma latum (Koch, 1844)
Amblyomma nuttalli Dőnitz, 1909
Amblyomma quadricavum Schulze, 1941
Amblyomma transversale (Lucas, 1845)
Amblyomma varanense (Supino,1897)

Subfamily: Hyalomminae Hoogstraal, Aeschliman, 1982

Genus: *Hyalomma* Koch, 1844
Hyalomma aegyptium Linnaeus,1758)
Hyalomma marginatum Koch, 1844

Subfamily: Rhipicephalinae Salmon et Stiles, 1901

Genus: *Rhipicephalus* Koch, 1844
Rhipicephalus rossicus Jakimov et Kohl-Jakimova, 1911
Rhipicephalus sanguineus (Latreille, 1806)

A review of recorded tick species transferred to Poland

Ixodes eldaricus Djaparidze, 1950;

syn. *Ixodes tatei* Arthur, 1956

Zoogeographical and parasitological characteristics

The geographical range of *I. eldaricus* determined to date, covers Southern Ukraine (Crimea), Georgia, Azerbaijan, Armenia, Kazakhstan, Turkmenistan, Kyrgyzstan, Uzbekistan, Tajikistan, and Russia (Dagestan) [8,9]. On the border between Iraq and Turkmenistan, the majority of locations were recorded in the Kopet Dag mountain range. The occurrence of *I. eldaricus* has also been reported on birds in Cyprus [10], and in Israel, where it was described under the name of *Ixodes tatei* Arthur, 1956, a junior synonym of *I. eldaricus*, a species that lives chiefly in mountain deciduous forests in mountain river valleys at elevations of up to ca. 1,800 m a.s.l. [8,9].

All developmental stages of this tick dwelling outside nests infest chiefly bird species nesting near the ground or searching for food on the ground surface. Among the hosts 29 bird species have been reported, belonging to 13 families: Phasianidae, Laridae, Strigidae, Alaudidae, Motacillidae, Prunellidae, Turdidae, Sylviidae, Sittidae, Corvidae, Passeridae, Fringillidae, and Emberizidae. Publications have also reported isolated cases of *I. eldaricus* feeding on bats (Chiroptera) in Azarbaijan, on rodents (Rodentia) and insectivores (Insectivora) in the western Kopet Dag mountain range, and in Israel [11,12], as well as on foxes (*Vulpes*) [10]. There were cases of these ticks being found on human clothing [8].

No information is available on the epidemiological or economic importance of this species.

Cases of natural transfers to Poland

Ticks were collected on the Hel Peninsula in Poland during 'Operation Baltic', an ornithological survey. One female tick was feeding on *Prunella modularis,* and one female and two males were found feeding on *Erithacus rubecula*. *P. modularis* and *E. rubecula*, species on which the transfer of *I. eldaricus* took place, have not been earlier recorded among the hosts of this species [2].

Ixodes festai Rondelli, 1926;

syn. *I. ventalloi* (Gilot & Perez, 1978)

Zoogeographical and parasitological characteristics

This species occurs in the western and southern parts of the Mediterranean zone (France, Corsica, Italy, and on Sardinia, Ventotene, and Montecristo islands, as well as in Morocco, Tunisia and Libya) [9,13].

A parasite dwelling outside of nests. The hosts are birds, most often those searching for food on the ground surface. The following bird species have been recorded as hosts: *Turdus philomelos*, *Turdus torquatus*, *Turdus iliacus*, *Turdus merula, Phasianus colchicus*, and *Alectoris barbara* [9,13,14]. Also collected on *Oryctolagus cuniculus* [15], and *Vulpes vulpes* [16]. No information on epidemiological importance is available.

The case of natural transfer to Poland

A female of this tick species was found on the Hel Peninsula in Poland, on *Turdus merula* [14].

Amblyomma sphenodonti Dumbleton, 1943;

syn. *Aponomma ludovici* Siuda, 1972

Zoogeographical and parasitological characteristics

A. sphenodonti occurs on islands of various sizes belonging to New Zealand (e.g. Stephen Island), its

distribution range is not fully known, even though the distribution of its principal host has been thoroughly studied. There are reports that the prevalence of *A. sphenodonti* ticks on the islands of New Zealand is decreasing, so researchers have therefore suggested considering this species as a candidate 'endangered' species, and placing it on the Red List of Endangered Species [17].

A. sphenodonti feeds exclusively on tuatara (*Sphenodon punctatus*) living on the coastal islands of New Zealand which is the only host of all developmental stages of this tick known to date [17-19]. The ticks infest tuataras in various habitats on these islands. These include animal burrows, shrub areas in coastal zones, as well as shaded habitats where they prefer moist soil and rudaceous substrate [17,19,20]. Recent studies have not proven any adverse effects of tick infestation on hosts but the effect of diseases transferred by ticks have not been studied [17].

The case of accidental transfer to Poland

There is a single report of accidental transfer of *A. sphenodonti* (syn. *Aponomma ludovici* Siuda 1972) from New Zealand to Poland on a tuatara (*Sphenodon punctatus*) which was donated as a gift to the Jagiellonian University in Krakow [21,22].

Amblyomma exornatum (Koch, 1844);

syn. *Aponomma arcanum* (Karsch, 1879)

Zoogeographical and parasitological characteristics

A. exornatum is widespread across Africa: Algeria, Senegal, Ivory Coast, Ghana, Cameroon, Gabon, Congo, Somalia, Kenya, Angola, Tanzania, Botswana, Mozambique, and the Republic of South Africa [9,19,23].

The chief hosts of *A. exornatum* are reptiles, most often monitor lizards (Varanidae), skink lizards (Scincidae), and pythons (Boidae). The species has been also recorded on: Testudinidae, Crocodylidae, Chamaeleonidae, Colubridae, Elapidae, and Viperidae. *A. exornatum* also feeds on mammals, most often bats (Chiroptera), pangolins (Pholidota), rodents (Rodentia), even-toed ungulates (Artiodactyla), particularly bovids (Bovidae), and carnivores (Carnivora) [9,19,23,24].

It has been shown that *A. exornatum* can be a natural vector of *Coxiella burnetii* and *Rickettsia* pathogens in the group of spotted fevers, but there is no information available as to whether *A. exornatum* has any role in the transmission of Q fever [25-27].

Cases of accidental transfers to Poland

Thirty three specimens of *A. exornatum* were accidentally transferred to Poland on savannah monitor lizards (*Varanus exanthematicus*) from Ghana (Africa). These reptiles were intended for terrarium-breeding [1,4,28].

Amblyomma flavomaculatum (Lucas, 1846);

syn. *Aponomma inopinatum* Santos Dias, 1989 (Fig. 1)

Zoogeographical and parasitological characteristics

A. flavomaculatum is widely distributed across West and Central Africa. In the west of Africa it occurs in locations within Mauritania, Mali, Senegal, Guinea, Sierra Leone, Ivory Coast, Burkina Faso, Ghana, Togo, Benin. In Central Africa it occurs in Niger, Chad, Sudan, Nigeria, Cameroon, and the Central African Republic [9,19].

A specific parasite of lizards (Sauria) chiefly monitor lizards (Varanidae), but also of snakes (Serpentes) [9,19,24].

The epidemiological studies of ticks transferred to Poland confirmed the occurrence of *Anaplasma phagocytophilum* in two *A. flavomaculatum* specimens [29].

Cases of accidental transfers to Poland

425 specimens of these ticks were transferred from Africa (Ghana) to Poland on savannah monitors (*Varanus exanthematicus*), and one specimen on a green iguana (*Iguana iguana)* from El Salvador (Central America) [1,4,28]. These reptiles were intended for private terrarium-breeding.

Amblyomma latum (Koch, 1844);

syn. *Aponomma ochraceum* Neumann, 1901 (Fig. 2)

Zoogeographical and parasitological characteristics

A. latum occurs on almost the entire African continent, from Senegal to the west to Ethiopia to the east, and from Egypt to the north, up to the Republic of South Africa to the south [19]. *A latum* was also recorded in Asia (India, Sri Lanka, and Yemen) [9,30-32].

The hosts of *A. latum* are reptiles, most often Elapidae, Colubridae, Viperidae, Boidae,

Fig. 1. Male (A) and female (B) of *Amblyomma flavomaculatum*

Fig. 2. Male (A) and female (B) of *Amblyomma latum*

Pythonidae, Testudinidae, Sauria, Scincidae, and Varanidae. Incidental cases of these ticks have been recorded on insectivorous mammals (Insectivora), and small rodents (Rodentia) [9,19,24]. All active developmental stages of *A. latum* can feed on the same host.

It is likely that *A. latum* participates in the transmission of *Ehrlichia ruminantium* causing animals to suffer from heartwater disease [33].

Cases of accidental transfers to Poland

In a consignment of reptiles sent from Ghana to Poland, intended for private terrarium-breeding, 1068 specimens of *A. latum* were found transferred on royal pythons (*Python regius*), and two specimens – on a savannah monitor lizard (*V. exanthematicus*) [1,4,28]. This tick species is considered to be the most frequently transferred outside its natural range of distribution among the species of genus *Amblyomma* [1,34,35].

Amblyomma nuttalli Dőnitz, 1909

Zoogeographical and parasitological characteristics

A tick species widespread on the African continent, with locations recorded in the following areas: Senegal, Guinea-Bissau, Guinea, Sierra Leone, Ivory Coast, Ghana (Gold Coast), Benin, Niger, Chad, Sudan, Nigeria, Cameroon, Central African Republic, Democratic Republic of the Congo, Uganda, Kenya, Angola, Malawi, Tanzania, Zimbabwe, Mozambique, and the Republic of South Africa [9,30].

The pool of hosts of *A. nuttalli* is diverse, including reptiles, birds, and mammals. *A. nuttalli* feeds most often on reptiles, above all on tortoises (Testudinidae), monitor lizards (Varanidae), on snakes of the viper family (Viperidae). Less frequently, hosts include representatives of Pleurodina, Agamidae, and Boidae. Mammals (Mammalia) are also numerous group of hosts for *A. nuttalli*, it includes insectivorous mammals (Insectivora), primates (Primates), rodents (Rodentia), even-toed ungulates (Artiodactyla), and carnivores (Carnivora). There are sporadic records of these ticks on humans and domestic pets – dogs and cats [9,24]. It was found that *A. nuttalli* can transmit *Coxiella burnetii* between its hosts [25].

Fig. 3. Male (A) and female (B) of *Hyalomma aegyptium*

Cases of accidental transfers to Poland

Five specimens of *A. nuttalli* were transferred from Ghana to Poland on savannah monitor lizards (*V. exanthematicus*). These reptiles were intended for sale and private terrarium-breeding [1,4,28].

Amblyomma quadricavum Schulze, 1941;

syn. *Aponomma quadricavum* Schulze, 1941; ***Amblyomma arianae* Keirans and Garris, 1986**

Zoogeographical and parasitological characteristics

A Central American tick species, known to occur in Cuba, Haiti, Puerto Rico and Jamaica [9,36,37]. Cases of *A. quadricavum* ticks were documented on boa snakes (Boidae), and vipers (Viperidae), as well as on lizards of genus *Iguana* [1,9].

Cases of accidental transfers to Poland

Five specimens of this tick, transferred to Poland, fed on green iguanas (*Iguana iguana*). The hosts were transported from Central America (El Salvador) and intended for sale and private terrarium-breeding [1,4].

Amblyomma transversale (Lucas, 1845)

Zoogeographical and parasitological characteristics

The distribution of *A. transversale* covers Sub-Saharan Africa. It was found in the following countries: Senegal, Guinea, Ivory Coast, Cameroon, Congo, Uganda, Tanzania, Mozambique, and the Republic of South Africa [9,19].

A. transversale ticks feed chiefly on boa snakes (Boidae), the highest numbers were found on pythons (Pythonidae). Even-toed ungulates (Artiodactyla), particularly African buffaloes and antelopes (Bovidae) are considered to be accidental hosts of *A. transversale* [9,24].

Cases of accidental transfers to Poland

In a consignment of reptiles from Africa (Ghana), five specimens of this tick was recorded on royal python (*Python regius*) hosts [1,4]. The reptiles were destined for sale to private breeders.

Amblyomma varanense (Supino, 1897)

Zoogeographical and parasitological characteristics

These ticks occur in South and Southeast Asia, Pakistan, India, Sri Lanka, Myanmar (Burma), on Narcondam and Nicobar islands, in Thailand, Cambodia, Vietnam, Singapore, Malaysia, Indonesia (on Sumatra, Java, Lingga, Bawean, Flores, Borneo, Ternate islands) as well as in the Philippines [24].

Reptiles are specific hosts for this tick species. The most frequently reported hosts are representatives of Boidae, Pythonidae, Testudinidae, Varanidae, and Viperidae. Accidental feeding by *A. varanense* was recorded on birds and mammals, among the latter group, on even-toed ungulates (Artiodactyla), canids (Canidae), and felids (Felidae) [19].

Cases of accidental transfers to Poland

One specimen of this species, transferred to Poland was recorded on a water monitor (*Varanus salvator*), brought from Asia (Indonesia) [1,4,28].

Hyalomma aegyptium (Linnaeus, 1758);

syn. *Acarus aegyptius* Linnaeus, 1758 (Fig. 3)

Zoogeographical and parasitological characteristics

The geographical range of *H. aegyptium* spans from the northwestern areas of Africa, across the Italian Peninsula, the Balkans, Asia Minor, Transcaucasia, the Black Sea coast, and the northern part of the Middle East up to Central Asia [9,38-40].

All developmental stages of this species feed chiefly on tortoises (Testudinidae) and on lizards of the family Agamidae. Nymphs and adults were found on birds and mammals, most often on representatives of Lagomorpha, Perissodactyla, Equidae, Artiodactyla, Suidae, Camelidae, Carnivora and Canidae [9,24,41]. It also feeds on humans, as such cases were recorded in Turkey [42].

This species is very important in veterinary medicine because of the transmission of pathogens in populations of hosts. A number of important pathogens were found in *H. aegyptium* e.g. *Rickettsia conori*, *Coxiella burnetii*, *Ehrlichia canis, Anaplasma centrale*, *Anaplasma marginalne*, *Anaplasma ovis*, *Anaplasma phagocytophilum, Hepatozoon kisrae*, *Hemolivia mauritanica* [25,43-46]. Mans et al. [47] report possible tick paralysis caused by a feeding *H. aegyptium* tick on a systematically unclassified tortoise.

Cases of accidental transfers to Poland

The earliest data on the accidental transfer of *H. aegyptium* to Poland (Chorzów, Wieliczka) on

tortoises were recorded by Siuda [48,49]. The tortoises with the ticks feeding on them, were brought by Polish tourists from the Balkans and former Yugoslavia. A further case of transfer was noted during the inspection of a consignment of tortoises (*Testudo graeca*, *Testudo marginata*) from Greece, intended for sale and terrarium-breeding. 8 specimens of *H. aegyptium* were found on spur-thighed tortoises *Testudo graeca*, 70 specimens of ticks were collected from marginated tortoises *Testudo marginata* [1,28].

Group of species: *Hyalomma marginatum* Koch, 1844;

syn. *Hyalomma plumbeum* (Panzer, 1795)

The taxonomic status of *Hyalomma marginatum* group of species has been debated for years [50–52]. Apanaskevich [51,52] considered four subspecies (*Hyalomma marginatum marginatum*, *Hyalomma marginatum isaaci*, *Hyalomma marginatum rufipes*, and *Hyalomma marginatum turanicum*). Molecular studies and a renewed review updated the status of each subspecies to the rank of species [53,54]. Studies to date indicate that ticks of *H. marginatum* species complex (*H. marginatum*, *H. rufipes*) can be considered as moving most often on migratory birds onto areas further north of their natural range e.g. to Sweden, Denmark, Norway, Finland, Germany, Great Britain, and Poland [55–59]. Balashov [60] reports that each year great numbers of nymphs of *H. marginatum* are transferred on birds into Central and Northern Europe. Some authors suggest that there is a slow process of adaptation and development of these Afro-Mediterranean ticks in the continental climate of Central Europe [61]. It is very difficult to distinguish juvenile stages of the ticks of these species by morphology and to properly identify them. Therefore, most of the samples are undetermined [51,52]. Another issue is the nomenclature of these ticks, since the authors of papers use the names of species and subspecies differently.

Hyalomma marginatum Koch, 1844

Zoogeographical and parasitological characteristics

The range of occurrence of *H. marginatum* covers Southern Europe, Ukraine, southern Russia, North Africa, and the Middle East. This species is adapted to living in various landscape zones, most often it occurs in steppe, foothill-steppe, and forest-steppe environments with a Mediterranean climate.

The hosts of adult ticks are chiefly wild or domestic ungulates (Ungulata) [54]. Juvenile forms parasitize birds, often migratory birds which can transport them over significant distances [62]. *H. marginatum* is a two-host parasite, the moulding of a larval stage into a nymph may occur on the same host which enables ticks to stay longer on one host, even as long as 27 days [63]. Within their natural range of distribution, these ticks often attack humans [42,59,64-66].

H. marginatum is considered to be a principal transmission agent and reservoir for the virus of the Crimean-Congo haemorrhagic fever, and it also transmits Bahig, Matruh, and Dhori viruses. Also discovered were other pathogens: *Rickettsia aeschlimanii*, *Coxiella burnetii*, *Babesia caballi*, *Babesia equi* and *Theileria annulata* [67-69]. The Omsk haemorrhagic fever, and Astrakhan viruses, as well as *Francisella tularensis* bacteria have also been found in these ticks (syn. *H. plumbeum plumbeum*) [70,71].

Cases of natural transfers to Poland

Two cases of transfer of *H. marginatum* on birds into Poland have been recorded to date. Siuda and Dutkiewicz [72] described a case of transfer on *Motacilla flava* to Popielno (Puszcza Piska forest, Suwałki voievodship). Nowak and Solarz [58] noted a case of transfer on *Acrocephalus schoenobaenus* to Umianowice (Pińczów poviat, Świętokrzyskie voivodeship).

Rhipicephalus rossicus Jakimov et Kohl-Jakimova, 1911;

syn. *Rhipicephalus sanguineus rossicus* Zumpt, 1939

Zoogeographical and parasitological characteristics

The species occurs in Europe and Asia, e.g. in Bulgaria, Romania, Moldova, Ukraine, Russia, Georgia, Armenia, Azerbaijan, Kazakhstan, Turkmenistan, Uzbekistan, Iran, China, and Egypt (Sinai) [9,73].

Adult stages of *R. rossicus* parasitize various small and large mammals, either domestic animals or wild carnivores, sporadically humans. Nymphs and larvae choose smaller animals e.g. rodents (Rodentia), rarely birds (Aves) [9,38].

The epidemiological studies of this tick species showed that it is a natural vector of Crimean-Congo

haemorrhagic fever [74], as well as of *Coxiella burnetii*, *Francisella tularensis*, *Brucella* sp., *Salmonella* sp., *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Babesia bigemina*, and *Babesia gibsoni* [9,38].

The case of natural transfer to Poland

One case of natural transfer on mammals was registered in Poland: *R. rossicus* was collected from a cow in Machnów (southeastern Poland) [75].

Rhipicephalus sanguineus (Latreille, 1806);

syn. *Ixodes sanguineus* Latreille, 1806

Zoogeographical and parasitological characteristics

The distribution range of *R. sanguineus* covers most continents and a number of islands, and therefore it is the world's most widely distributed tick species. The natural range of *R. sanguineus* covers Africa, the Mediterranean region and the Black Sea region in Ukraine, Transcaucasia, Turkmenistan, Iran, and the Middle East [39,40, 76–78]. The data obtained in recent years on the extended range of occurrence of *R. sanguineus* across the world, pertained, for example, to Mexico, South and Central America, Brazil, Argentina, USA and Japan. Within its original range of distribution, it lives chiefly in steppe habitats, in other areas of occurrence – in synanthropic habitats (yards, livestock stables). It is known that *R. sanguineus* is capable of surviving in humans, as well as in livestock buildings including dog kennels [3,79]. *R. sanguineus*, referred to as 'dog's tick', is an interesting example of tick species artificially transferred onto all continents of the world on its hosts – domestic dogs.

The specific hosts of *R. sanguineus* are mammals, particularly domestic dogs (*C. familiaris*) and other canids (Canidae), and the life cycle of ticks is usually completed in dog kennels [3,30,40]. These ticks sporadically attack other hosts, particularly mammalian predators (Carnivora), ungulates (Ungulata), insectivores (Insectivora), and – rarely – birds. Juvenile stages also feed on rodents (Rodentia) [42,73,80]. Cases of *R. sanguineus* feeding on humans are sporadically reported in specialist literature [81]. It is probable that all developmental stages of *R. sanguineus* can attack humans although opinions on this topic are divergent.

R. sanguineus is an important vector of tick-borne diseases among humans and animals, particularly those associated with tick-borne diseases in dogs. It is a recognised vector of Crimean-Congo haemorrhagic fever virus, and Thogoto virus in Southern Europe and of *Rickettsia conorii* ssp., *Rickettsia massiliae*, *Rickettsia rickettsii*, *Coxiella burnetii* pathogens which can be transmitted to humans [59,82,83]. *Ehrlichia canis*, *Babesia canis, Babesia canis vogeli*, *Babesia gibsoni*, and *Hepatozoon canis* represent the pathogens which can also be transmitted by *R. sanguineus*, causing severe diseases in dogs [59,84]. It is suggested that *R. sanguineus* can be involved in the transmission of *Leishmania infantum* – a factor of visceral leishamaniasis, and of *Dipetalonema dracunculoides* causing canine filariasis [85,86].

Cases of accidental transfers to Poland

A fully documented account of the infestation of dogs by *R. sanguineus* was presented by Szymański [3]. A Polish family and an Italian family were spending their holidays together with their dogs near the Puszcza Piska forest in the Mazurian region of Poland. Most likely, the ticks spread to the Polish dog when dogs of both families were playing and walking together. The infestation was noticed only after they returned to Warsaw where the ticks settled into the Polish family's comfortable accommodation. After some time, the ticks transferred to the Warsaw flat were successfully eradicated, but they sporadically reappeared over several consecutive months. They have never been collected from humans although they had been noticed on clothing and linen [3 and unpublished personal information]. Żukowski [79] described further cases of occurrence of *R. sanguineus* in flats in Warsaw. In most cases, the places where dogs were infested with these ticks could not be determined. These were usually various Polish locations where dogs had been living during the holiday season.

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