

Expansion of *Dermacentor reticulatus* in central-southern Poland and new threats to human and animal health

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Abstract

Dermacentor reticulatus is one of the tick species with the greatest epidemiological importance in Europe. To date, the Eastern European and Western European populations of this tick species have been separated by an area located in Poland where the species have never been found. In this paper, we describe newly discovered *D. reticulatus* localities in areas transformed by human activities in central-southern Poland. These specimens of ornate dog tick were identified among ticks collected from companion animals in 2010, 2012, 2013, and 2014.

Our results verify the available data on the spread of ornate dog tick and indicate that, since 2010, this tick species has probably been present in this area, which has a strongly transformed agricultural structure and used to be regarded as a *D. reticulatus*-free zone. However, field studies are required to determine the current distribution range of *D. reticulatus* and its population size.

The presence of the ornate dog tick in urban and suburban habitats in central-southern Poland poses new threats to the health of companion animals and humans associated with the transmission of pathogens by this species.

Introduction

The meadow or ornate dog tick *Dermacentor reticulatus* (Fabricius, 1794) was regarded as one of the most expansive tick species at the turn of the 21st century. Its geographical range has increased across Europe^{1,2}, especially in its northern, central, and eastern parts. The boundary of the *D. reticulatus* occurrence in the west and east of the continent, historically referred to as Western European and Eastern European populations, has been regarded as a tick-free area in Poland³.

The spread and increase in the abundance of *D. reticulatus* have been caused by climate and environmental changes, which create favorable conditions for the species in various geographical regions⁴⁻⁷.

The climate warming and weather phenomena recorded recently in Europe have contributed to prolonged seasonal activity of adults of this species, which may begin in early March and last until December in the northern and central parts of the continent. The first activity peak is recorded from April to May in spring, and the next peak occurs in late summer and autumn, usually persisting from mid-August/early September to November^{5,8,9,10,11}. Currently, host seeking *D. reticulatus* specimens can be found even in winter months at an ambient temperature of approximately 0°C in the absence of snow cover^{9,10,12}. Juvenile stages of this tick species are active in summer and autumn, with the highest activity of larvae observed in June or July and nymphs in July or August, depending on the region¹³⁻¹⁶.

In the European part of Eurasia, the entire life cycle of *D. reticulatus* from oviposition to adult stages usually lasts from 1 to 2 years¹⁷. In laboratory conditions at a temperature of 20°C±3°C and 75% relative

humidity, the life cycle of this tick is completed within one year (author's unpublished data). Unengorged adults can live even 3-4 years¹⁷. Their longest survival of 617.8 days was recorded at 5°C and 100% R.H. and the shortest lifespan (33.6 days) was noted at 27°C and 15% R.H.¹⁸. In the temperature range from 5°C to 27°C and at relative humidity from 15% to 100%, the mortality rate of unengorged adults was reported to increase, regardless of their sex, with an increase in relative humidity and a temperature decline.

D. reticulatus is mainly transported to new habitats by migrating mammals, mainly representatives of Cervidae and carnivores^{19,20}. Companion animals traveling with their keepers may also play a role in the spread of adult ticks^{21,22}. Additionally, birds may be involved in the transmission of *D. reticulatus*, as its larvae have been collected from these animals²³. Further research is necessary to determine the role of these hosts in the spread of *D. reticulatus* in nature.

The colonization of various habitats by the ornate dog tick is supported by its special adaptation abilities and biological and physiological features, e.g. high tolerance to humidity and temperature conditions^{5,7,8,15,18,23,24}. Moreover, this tick species is characterized by a wide range of hosts of juvenile^{15,23} and adult^{1,19,22,25} stages, which facilitates finding sources of food (blood) necessary for further development in new habitats. Across its entire geographical range, *D. reticulatus* adults infest dogs (*Canis lupus familiaris*)¹, which may play an important role in the maintenance of the population of this tick in urban environments. Companion animals, especially dogs, may be involved in the circulation of tick-borne pathogens transmitted by the ornate dog tick in urban areas²⁶.

The expansion of the *D. reticulatus* occurrence range and changes in their phenology have increased the exposure of tick hosts to infection by various pathogens transmitted during feeding, e.g. tick-borne encephalitis virus (TBEV), spotted-fever group rickettsiae (SFGR), *Babesia* spp., *Theileria equi*, and *Francisella tularensis*¹.

In Europe, *D. reticulatus* is one of the most important vectors of *Babesia* spp., i.e. the causative agent of canine babesiosis posing a high risk of death in dogs²⁷ and spotted fever group rickettsiae¹, e.g. *Rickettsia slovaca* and *Rickettsia raoultii* bacteria from the SF group responsible for a syndrome characterized by scalp eschars and neck lymphadenopathy following tick bites (SENLAT).

In this paper, we describe new localities of *D. reticulatus* in a zone that has so far been free of this species in central Poland and we draw attention to the consequences of the presence of the tick to animal and human health.

Results and Discussion

In this study, *D. reticulatus* ticks were found for the first time in central-southern Poland in three localities (Radomsko, Żytno, and Kłobuck) situated at a distance of approx. 25-60 km from each other (Fig. 1). To

date, this area has been regarded as a zone separating the eastern and western ornate dog tick populations in Poland³.

In total, six *D. reticulatus* specimens were collected from six dogs and one specimen was removed from one cat (Fig. 2, Table 1). There were three fully engorged females, one partially engorged female, and three males. As declared by the keepers of the dogs and cat, their animals stayed in the same area throughout the study period.

The incidents of attachment of *D. reticulatus* adult ticks to companion animals in different study years indicate that this species has probably been present in central-eastern Poland since 2010. The collection of the *D. reticulatus* specimens in central-southern Poland confirms the findings of the rapid migration of this tick in Poland reported by other researchers^{3,30,31}.

Table 1. *Dermacentor reticulatus* ticks collected from companion animals in central-southern Poland (2010-2014).

Date of collection	Collection site	Host species	Anatomical location on host	Life stage of removed tick
22.10.2010	Radomsko *	<i>Canis lupus familiaris</i>	head	almost fully engorged female
11.05.2012	Radomsko	<i>Canis lupus familiaris</i>	abdomen	partially engorged
10.04.2012	Radomsko	<i>Felis catus</i>	head	male
03.05. 2013	Kłobuck **	<i>Canis lupus familiaris</i>	head	male
27.05.2014	Radomsko	<i>Canis lupus familiaris</i>	head	male
20.06.2014	Kłobuck	<i>Canis lupus familiaris</i>	neck	almost fully engorged female
10.05.2014	Żytno ***	<i>Canis lupus familiaris</i>	leg	almost fully engorged female

geographical coordinates of collection sites * 51°04'01"N, 19°26'41"E, 223 a.s.l.; ** 50°54'02"N, 18°56'12"E, 239 a.s.l.; *** 50°55'38"N 19°37'39"E, 202 a.s.l.

The incidents of attachment of *D. reticulatus* adult ticks to companion animals in different study years indicate that this species has probably been present in central-eastern Poland since 2010. The collection of the *D. reticulatus* specimens in central-southern Poland confirms the findings of the rapid migration of this tick in Poland reported by other researchers^{3,30,31}.

At the end of the 20th century and the beginning of the 21st century, the eastern and western *D. reticulatus* occurrence range in Europe was separated in Poland by an area between the Vistula River and the Oder River³². The first localities of *D. reticulatus* west of the Vistula River were recorded in Pomeranian Lake District in the early 2000s^{33,34} and in subsequent years, as reported by Dwużnik-Szarek et al.³.

In western Poland, the tick species was first found near the border with Germany in Dolnośląskie and Lubuskie Provinces³⁵⁻³⁸. In 2022, *D. reticulatus* specimens were collected near Poznań (west-central Poland)³⁹. Two specimens (one female and one male), probably from a local population, were removed from a dog in Racibórz in south-western Poland⁴⁰.

Dermacentor reticulatus ticks were probably brought to the area analyzed in this study by animals migrating from the western regions of Poland and/or eastern Germany, where stable populations of this species have been identified^{4,6}. The new *D. reticulatus* localities in central Poland are situated in or near urbanized areas. The shift in the range of these ticks towards urban areas has been observed for two decades in other parts of Poland^{39,41-45} and Europe^{10,46-48}.

The environmental conditions in central Poland are highly favorable for this tick species. Within its distribution range, the species is most often found in riparian forests, river and lake banks, meadows, mid-forest clearings, and wastelands with a high groundwater level^{1,7,8,23,24,30,31}. The *D. reticulatus* colonization of the study area may have been facilitated by human activities changing the hydrographic network (conversion of smaller tributaries of the main rivers in the region into drainage ditches and construction of drainage ditches, regulation of rivers, construction of artificial water reservoirs) and landscape transformation (mid-field afforestation, fallow areas, urbanization, conversion of forests into agricultural land). The mosaic landscape creates not only open habitats preferred by *D. reticulatus* ticks but also various habitats suitable for their potential hosts in central Poland. The relationships between the reduction of forested areas and the presence of *D. reticulatus* were confirmed by Mierzejewska et al.⁴⁹.

In Poland, juvenile stages of *D. reticulatus* (larvae and/or nymphs) have been collected from various species of rodents from the families Murinae, Microtinae, and Soricidae^{13,14,16,50-52}, and nymphs have also been found to infest larger mammals, e.g. deer, roe deer, hares, and rabbits³². Adult ticks parasitize large wild-living mammals, mainly representatives of the families Cervidae: *Alces alces* (moose), *Dama dama* (fallow deer), and *Cervus elaphus* (red deer)^{34,38,53}, Canidae: *Canis lupus* (wolf) and *Vulpes vulpes* (fox)⁵⁴, Bovidae: *Bison bonasus* (European bison)⁽⁵⁵⁾, and Suidae - *Sus scrofa* (wild boar)^{38,56}. In the *D. reticulatus* occurrence range, adult specimens are collected from dogs and other domestic animals^{43,45,57}. In some habitats of central-eastern Poland, it is the dominant tick species infesting dogs⁵⁷.

The presence of *D. reticulatus* ticks in the study area poses a threat to the health of not only companion animals but also humans, who may be accidental hosts of adult stages^{22,25,58}. An interesting case of attachment of a female *D. reticulatus* tick to human skin was recorded in eastern Poland; the tick was transferred to the apartment by the pet dog (Buczek et al., unpublished data). As demonstrated by our research, after ingestion of dog's blood, female *D. reticulatus* ticks can lay eggs that hatch into larvae in household conditions.

The high risk of *D. reticulatus* attacks on companion animals and humans is also associated with the fact that adult specimens are active throughout the day, mainly from 12:00 to ca. 16:00 in spring and from 10:00 to approx. 18:00 in autumn with a peak around 14:00 in both these seasons, i.e. at the time of possible presence of their hosts in tick habitats⁵⁹.

The expansion of *D. reticulatus* ticks into central-southern Poland may lead to the spread of pathogens transmitted by this species in the environment, which should be taken into account in the clinical diagnosis of tick-borne diseases in domestic animals and humans. In Poland and its western and southern neighbors, numerous pathogens with medical and veterinary importance have been detected in this tick species, e.g. *R. raoultii* and other SFG rickettsiae, *Babesia* spp., TBEV, *Anaplasma phagocytophilum*, and *Francisella tularensis*^{43,60-63}. Spotted fever group rickettsiae, mainly *R. raoultii*, exhibit the highest prevalence in *D. reticulatus*. In western Poland, they were detected in 38.3% of specimens collected from vegetation⁴³ and in 60% of ticks removed from dogs⁶³. In the endemic regions in eastern and northern Poland, the percentage of host seeking *D. reticulatus* infected with these bacteria ranged from 34.18% to 56.7%⁶⁰⁻⁶². A high prevalence of *R. raoultii* and host seeking *D. reticulatus* specimens was also recorded in Poland's western and southern neighboring countries. The mean rates of infection with this bacterium were 64% -70.5% in Germany^{10,64} and 47.9% in the Czech Republic and Slovakia⁶⁵. Depending on the habitat, TBE viruses causing tick-borne encephalitis in humans were detected in 0.33%-10.8% of *D. reticulatus* specimens from the tick population in eastern Poland^{42,62,66}⁶⁷. The presence of TBE viruses in this tick species was reported from the district of northern Saxony near the Polish border⁶⁸.

The greatest threat to the health of dogs attacked by ticks is associated with the transmission of *Babesia* protozoa. In Poland, the prevalence of *B. canis* in ornate dog ticks is usually in the range of 1–4%, depending on the region^{61,62}. However, it can reach even 21.3% in swampy habitats in eastern Poland⁶⁹. The incidence of clinical babesiosis in the Polish population of dogs is higher in eastern and central Poland (Eastern tick population) than in western Poland (new endemic region for the ornate dog tick) and in the tick-free area³.

Conclusions

In conclusion, our observation has verified the data on the spread of *D. reticulatus* in Poland and confirmed its progressive expansion in Central Europe. The present results suggest that, since at least

2010, *D. reticulatus* ticks have been present in a zone in Poland that has so far been considered to be free of this species. Field studies (collection of ticks from vegetation) may indicate the distribution of these ticks and the size of their population in central-southern Poland.

The expansion of *D. reticulatus* to the areas of central-southern Poland enlarges the area of potential foci of diseases transmitted by this tick species, e.g. babesiosis in dogs and rickettsiosis in humans, which are both diagnosed in other parts of Poland. Given the high vector competence and the wide spectrum of *D. reticulatus* hosts as well as its co-occurrence with *Ixodes ricinus* in the same habitats, the analyzed tick species can significantly contribute to the circulation and maintenance of other tick-borne pathogens in the environment, which are one of the most important biological agents posing a threat to the health of companion animals and humans.

Monitoring the occurrence of this tick species can help develop strategies for reduction of the incidence of tick-borne diseases in humans and animals.

Methods

Study area

The study was carried out in central Poland: Radomsko and Żytno Communes in Łódzkie Province and Kłobuck Commune in Śląskie Province. The climate in this area is transitional, which is associated with the influences of air masses characteristic of the continental and oceanic zones. The climate in this region is also determined by differences in terrain elevation and soil moisture. In recent years, an increase in the mean air temperature has been observed in the study area.

The field and forest landscape of this area with relics of natural forest and meadow-peatland ecosystems are favorable habitats for numerous animal species that can be potential tick hosts, e.g. moose, red deer, fallow deer, roe deer, wild boar, hare, fox, raccoon dog, marten, badger, beaver, weasel, and stoat.

Radomsko Commune (51°04'01"N, 19°26'41"E, 223 a.s.l.) is situated in the valley of the Warta River and on Radomsko Hills. Its southern part is located in a nationally important ecological corridor covering the valley of the Warta River and in the area of the main underground water reservoir in Upper Cretaceous formations. Its area covers numerous wet meadows, swamps, and peat bogs, where many northern plants can be found (marsh horsetail, swamp sedge, several species of mosses, long-leaved chickweed, and wild rosemary). However, species characteristic of Central Europe, e.g. European beech, common hornbeam, English oak, broad-leaved linden, and Norway maple, are the most numerous plants. Herbaceous plants are represented by finger sedge, wood anemone, and dog's mercury. Riparian forests and oak-hornbeam forests are the dominant habitats in the valley of Warta tributaries. The plant cover in the valley bottom is closely related to the habitat conditions and land use. Mid-field tree stands and forests are characterized by a high degree of habitat degradation caused by changes (intensive drainage) or neglect of water relations. Areas of former mid-forest meadows provide a favorable living habitat for mammals and birds. Wetlands and forest coppices located near agricultural fields are frequent habitats

for roe deer and boars. The area comprises large forest complexes mainly with communities of fresh mixed coniferous forest, wet mixed coniferous forest, and alder forest. The tree stand is dominated by pine, alder, birch, and oak.

Żytno Commune (50°55'38"N 19°37'39"E, 202 a.s.l.) covers a largely swampy area between the Pilica and Warta River valleys. Marsh and peat wetlands are a frequent element of its landscape. Nearly 50% of the area is covered by forests dominated by pine trees. Dębowiec Nature Reserve was established in the commune to protect a natural oak-hornbeam forest with broad-leaved linden at the margins of its occurrence range and an elm-ash riparian forest with rare herbaceous plants. Dębowiec Reserve and the neighboring forest complexes are located in wet valleys covered with natural alder and ash forests. The proglacial valley and the old riverbeds of the Pilica River are covered by riparian forests, rushes, herbaceous plants, and wet meadows in addition to fertile oak-hornbeam forests.

Kłobuck Commune (50°54'02"N, 18°56'12"E, 239 a.s.l.) is located in the catchment area of the Warta River. Numerous smaller rivers flow from the wet valleys into its largest tributary, the Liswarta River. The vegetation of the area is represented by coniferous (56%), forest (27%), mountain (16%), and alder (1%) communities. Pine and larch are the main forest-forming species (66.4%), with a lower percentage of spruce, oak, maple, sycamore, elm, ash, birch, beech, and others²⁸.

Tick collection

Ticks were collected from companion animals (six dogs and a cat) during routine health checks carried out by veterinarians in the study area. Ectoparasites collected from the animals were stored in sterile plastic test tubes with 70% ethanol pending identification in the laboratory. The species and sex of the tick specimens removed from the skin of the animals was identified based on the guide to tick identification by Nowak-Chmura²⁹.

Declarations

Data availability

All data are available from the corresponding author upon reasonable request

Author contributions

M.R. collected the data, A.B. and M.R. performed the laboratory analysis, A.B., W.B., and M.R. wrote the final version of the manuscript. A.B. and K.B. visualization, K.B. editing and revision. All authors contributed to and approved the final manuscript.

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Figures

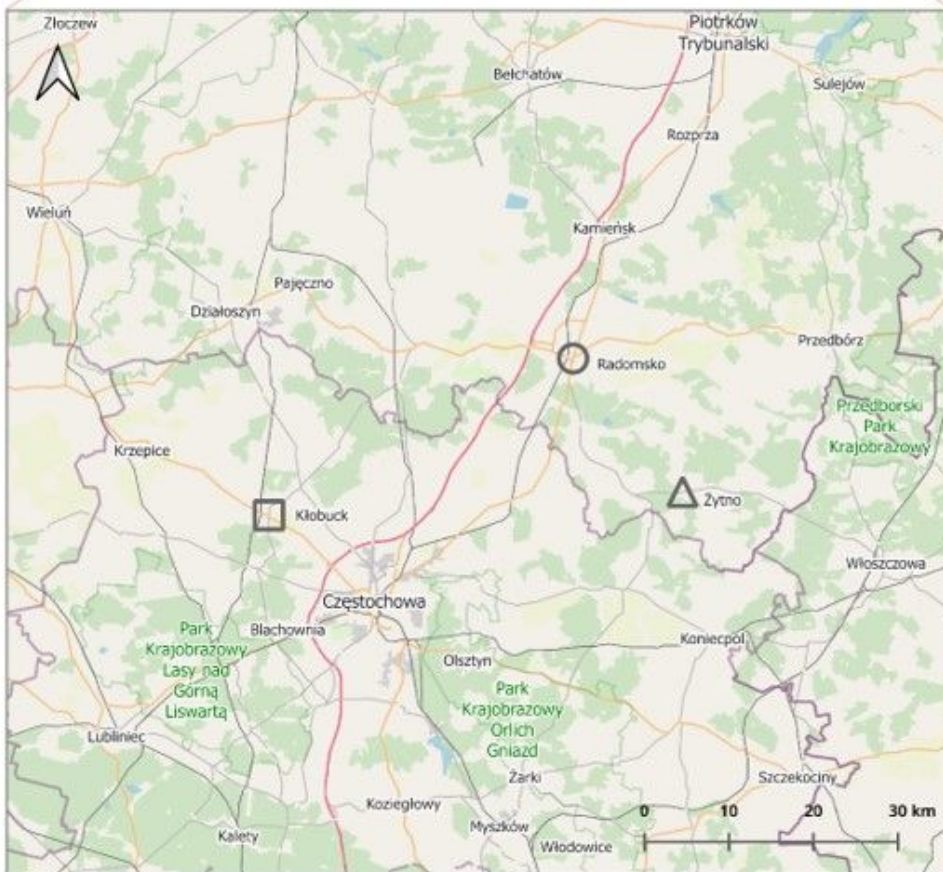


Figure 1

Geographical locations in Poland where *Dermacentor reticulatus* ticks were found on companion animals in 2010-2014. O- 51°04'01"N, 19°26'41"E, 223 a.s.l.; - 50°54'02"N, 18°56'12"E, 239 a.s.l.; D- 50°55'38"N 19°37'39"E, 202 a.s.l. (marcinwasilewski.eu on the basis of the OpenStreetMap; © authors OpenStreetMap).



Figure 2

Engorged female of *Dermacentor reticulatus* (arrow) collected from a dog's head in Radomsko in October 2010 (scale in cm).