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Short note

Estimated population size of *Dermacentor reticulatus* (Fabricius, 1794) ticks in an endemic area of the species in eastern Poland

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ABSTRACT. *Dermacentor reticulatus* ticks is one of the most important vectors and reservoirs of infectious microorganisms in Europe. In Poland, this species is common in areas east of the Vistula river, but increasing numbers of new localities are being reported in the west of the country. The aim of the study was to determine the estimated size of the *D. reticulatus* tick population in eastern Poland in different types of ecological habitats. To this order, the multiple mark-release-recapture technique was used. The largest estimated population size of *D. reticulatus* was noted in an agriculturally unused open meadow undergoing progressive ecological succession (344 ± 57.8 specimens/100 m^2). Besides the ecological type of the habitat, the availability of hosts probably exerts the greatest effect on the tick population size in the analyzed area.

Keywords: ticks, *Dermacentor reticulatus*, tick activity, tick populations

Introduction

Dermacentor reticulatus (Acari: Ixodida) ticks represent ectoparasites with the greatest medical and veterinary importance in Eurasia. It is primarily associated with the ability of this species to transmit numerous pathogens, e.g. the etiological factor of viral encephalitis and meningitis, rickettsial spotted fever, anaplasmosis, and babesiosis [1]. The direct negative effects of feeding of these ticks also include local and systemic lesions in hosts, such as tick-borne *Dermacentor*-borne necrosis erythema and lymphadenopathy (DEBONEL) and scalp eschar and neck lymphadenopathy (SENLAT), which are diagnosed frequently (SENLAT) [2,3].

In Poland, *D. reticulatus* is common in areas east of the Vistula river [4]. In recent years, there have been increasing numbers of reports of a dynamic increase in the size of its populations [5] and new localities of this species in the central and western parts of the country [6]. The occurrence range of the species in other parts of Europe is changing as well [7].

The aim of the study was to determine the expected size of *D. reticulatus* populations in ecologically different habitats in eastern Poland. The data can be useful for prediction of the risk of attacks by these arthropods.

Materials and Methods

The study area

The study was carried out in natural conditions in an area of occurrence of *D. reticulatus* ticks in eastern Poland (Lublin Province). The study covered three ecological sites representing different ecological types: Zawieprzyce (an unused agricultural meadow with progressive ecological succession), Nasutów (a meadow located in the immediate vicinity of a mixed forest, occasionally used as a pasture), and Lublin-Czechów (an urban meadow surrounded by detached houses with patches of synanthropic vegetation and progressive ecological succession). The latter area serves recreational functions for the residents of Lublin (Fig. 1). A 100-m^2 experimental plot was established in

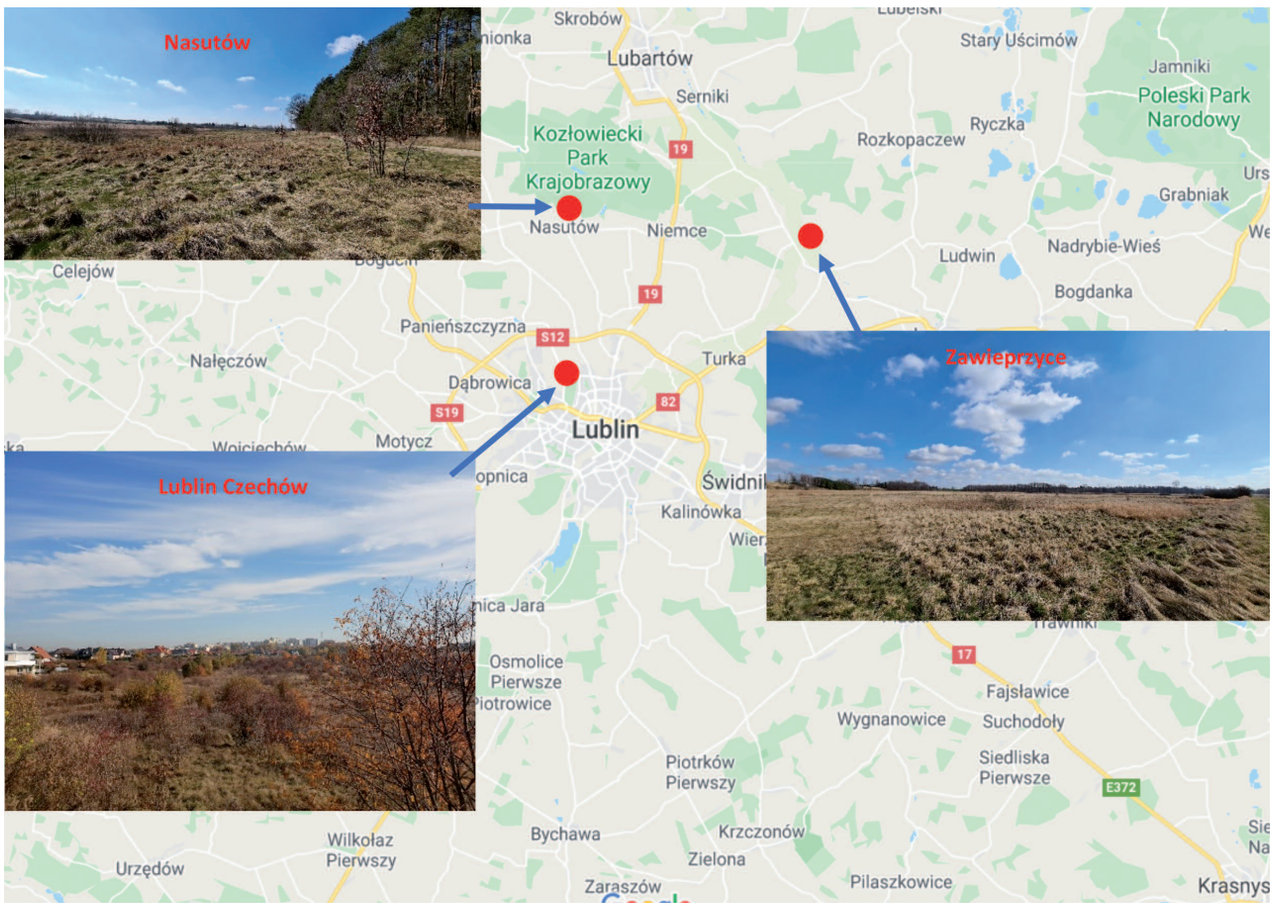

Figure 1. Localization of the study areas, based on Google Maps with own modifications

each locality.

Multiple mark-release-recapture technique

The repetitive activity of *D. reticulatus* ticks was analyzed at 7-day intervals during their seasonal activity (spring: 25.03–15.05.2019; autumn: 2.09–4.11.2019) using a modified multiple mark-release-recapture method [8]. No investigations were conducted in the summer months, when adult *D. reticulatus* ticks in eastern Poland exhibit no or largely limited activity [5]. Ticks were collected using the standard flagging method. Active adult ticks were marked on the dorsal side of the body with a permanent oil marker and then released at the collection site. Each time the ticks were marked with a different colour. A recapture of previously marked specimens was recorded as the rhythm of their repetitive activity. The ticks were identified as representatives of the *D. reticulatus* species using a hand-held magnifier by examination of the characteristic morphological features, i.e. the presence of a *scutum* pattern, the number of festoons, and the structure of palpi [9]. This procedure did not affect the ability of the ticks to move or their host-seeking activity, as the locomotor and sense organs remained free.

The weather conditions (temperature and relative air humidity) were assessed using the Data Logger R6030 device each time during the field study.

The differences in the numbers of active *D. reticulatus* ticks between the plots and the effect of prevailing weather conditions on their activity were analysed with the Kruskal-Wallis test. The significance level of $p<0.05$ was adopted in the statistical tests. Statistical analysis was carried out using software Statistica 10 PL.

The mark-release-recapture data were analyzed using Schnabel's modification of the Lincoln-Petersen index [8] according to the formula:

$$N = \frac{\Sigma M_i n_i}{(\Sigma m_i) + 1}$$

where N = population estimate; M_i = number of marked ticks in the population on day; i, n_i = number of ticks caught on day; i, and m_i = number of marked ticks caught on day i.

Table 1. Repetitions of *D. reticulatus* tick activity in the examined localities

Locality	Repetitions of activity											
	1×		2×		3×		4×		5×		6×	
	F	M	F	M	F	M	F	M	F	M	F	M
Zawieprzyce (n=336)	126	101	39	28	15	11	4	8	1	0	0	3
Nasutów (n=166)	27	30	20	13	10	15	15	15	10	3	5	3
Lublin-Czechów (n=141)	23	19	26	18	15	8	7	13	4	2	6	0

Explanations: F - females; M - males; n - number of active *D. reticulatus* ticks throughout the study period (including repetitive activity)

Standard errors of the estimates were calculated as follows [8]:

$$SE = N\sqrt{\frac{1}{(\Sigma m_i + 1)} + \frac{2}{(\Sigma m_i + 1)^2} + \frac{6}{(\Sigma m_i + 1)^3}}$$

Results

The studied *D. reticulatus* populations differed significantly in the number of active specimens (H=11.90, p=0.0026), the frequency of specimens' activity (Table 1), and their estimated population size (Table 2).

The highest numbers of active *D. reticulatus* ticks were recorded in Zawieprzyce. In the study period, in total 185 females/100 m^2 and 151 males/100 m^2 showed activity in this locality. Greater numbers of active females (87/100 m^2) than males (79/100 m^2) were also observed in the structure of the local *D. reticulatus* population in Nasutów. The lowest *D. reticulatus* population size was reported from the Lublin-Czechów locality, where 81 females/100 m^2 and 60 males/100 m^2 were active throughout the study (Fig. 2).

Table 2. Estimated *D. reticulatus* population size per 100 m^2 of the experimental plots

Locality	Estimated population size	
	N	SE
Zawieprzyce	344	58.7
Lublin-Czechów	148	27.9
Nasutów	178	22.7

Explanations: N - population estimate; SE - standard errors of the estimates

During the study, the average air temperature and humidity were 17.9°C and 65.8% in the spring and 16.2°C and 67.4% in the autumn, respectively. The activity of the analyzed ornate cow ticks was significantly correlated with the air temperature (H=8.887, p=0.0450).

During the 16 measurement days, the *D. reticulatus* ticks undertook activity from 1 to 6 times. In each experimental plot, the largest group comprised specimens that undertook the activity only once. An increased number of repetitions of the host-seeking activity were observed in Nasutów and Lublin-Czechów (Table 1).

The largest estimated population size of *D. reticulatus* adults (344±57.8 specimens/100 m^2) was recorded in Zawieprzyce (Table 2).

Discussion

Based on the results of investigations of the occurrence and abundance of *D. reticulatus* ticks in various regions of Poland, it can be assumed that the local population of this species in the Lublin region is one of the most numerous populations in country [5,6,10–13].

The results of the present study confirm the habitat preferences of *D. reticulatus* ticks in eastern Poland [5,14]. The largest population size of ornate cow ticks (Table 2) should be expected in habitats representing the ecological type of an open unused meadow undergoing progressive ecological succession. Additionally, significantly higher tick densities have been observed in abandoned lands in comparison to cultivated areas [15]. The specific niches emerging in these types of habitats offer

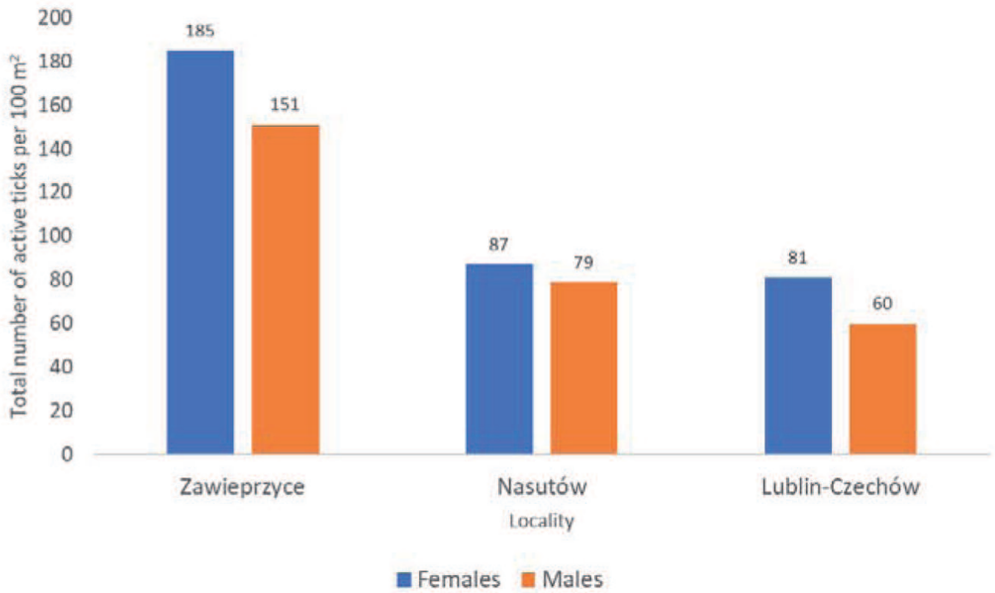

Figure 2. Total number of active *D. reticulatus* adults per 100 m^2 in the analysed localities

optimal conditions for colonization by rodents and small-sized wild mammals, thereby promoting the development of all stages of *D. reticulatus* ticks.

The size of ornate cow tick populations is limited by temporary use of meadows as pastures, and regular mowing significantly reduces the tick population size [16]. This relationship was also observed in the analysed localities. Despite the similar type of the ecological habitat, the sites in Zawieprzyce and Nasutów differed in the tick occurrence and the expected population size (Table 2).

Despite the smallest expected population size of *D. reticulatus* in the Lublin-Czechów locality, the plot was characterised by the most frequent repetitive activity undertaken by ticks (Table 2). This was probably associated with the limited access to hosts, which forced the ticks to undertake prolonged and frequent host-seeking activity. Therefore, this habitat poses a high risk of tick infestations of pets and potential attacks of humans.

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