

Seasonal activity of the common European tick, *Ixodes ricinus* (Linnaeus, 1758), in the forested areas of the city of Olsztyn and its surroundings

Katarzyna Kubiak¹ and Janina Dziekońska-Rynko²

¹Department of Genetics, University of Warmia and Mazury, Plac Łódzki 3, 10-957 Olsztyn; E-mail: katarzyna.kubiak@uwm.edu.pl;

²Department of Zoology, University of Warmia and Mazury, Oczapowskiego 5, 10-957 Olsztyn; E-mail: jdr@uwm.edu.pl

Corresponding author: Katarzyna Kubiak, Department of Genetics, University of Warmia and Mazury, Plac Łódzki 3, 10-957 Olsztyn; E-mail: katarzyna.kubiak@uwm.edu.pl

ABSTRACT. Common European ticks, *Ixodes ricinus*, have been found in forest areas situated within the boundaries of big cities, and in areas changed by anthropogenic pressure. Monitoring *I. ricinus*, in the areas used by the public for recreation and leisure, makes it possible to assess the risk of infection with the diseases they transmit. The objective of this study was the comparison of the seasonal activity of ticks, *I. ricinus*, in the afforested areas of the city of Olsztyn and its surroundings. **Material and methods.** This survey was conducted at sites located in the afforested areas of Olsztyn and within the Warmiński Forest situated about 15 km from Olsztyn. Ticks, *I. ricinus*, were caught every 10–14 days from April to October 2001 by the commonly applied method of flagging. During each catch, the temperature (T) and relative humidity (%RH) was measured with a thermohygrometer, 1 m above the duff level. **Results.** The tick population density at the Warmiński Forest site was higher than that at the sites within the city limits (116.8 and 20.5 ticks per 100 m², respectively). Two peaks of tick activity were recorded in this area — the spring peak in June and the autumn peak (much lower) in September. The activity of ticks in the afforested area within the city limits was much lower — only one (spring) peak occurred, which at most sites was observed in June. At all sites, included in the study, the peak activity of ticks was observed in April. **Conclusion.** The study suggests that the afforested areas outside the city are more dangerous to people than the area within the city because of the large number of ticks there.

Key words: *Ixodes ricinus*, larvae, nymphs, seasonal activity, ticks

Introduction

Among the 20 tick species living in Poland, the common European tick, *Ixodes ricinus* Linnaeus, 1758, is the most widespread [1]. *I. ricinus* ticks are haematophagous arachnids that feed on vertebrates, including humans. This may result in skin lesions, caused by the direct contact with the parasite (rash, dermatitis, allergies). Ticks may be vectors of numerous pathogenic viruses, bacteria, and protozoans [2–5]. The life cycle of ticks, *I. ricinus*, is a cyclical nature. This manifests itself in the alternating of lively activity, i.e. finding a host, feeding, development, metamorphosis, reproduction, with periods of diapause, synchronised with the seasons

of the year [6, 7]. The period of tick activity, its duration, and course are different in different climatic zones. The curve of the mass appearance of *I. ricinus* has one or two peaks. In the populations in Poland, hungry adolescent and adult ticks are active from spring to autumn, with two peaks of activity (in spring and autumn). If the summer is hot, the autumn peak of activity may be absent [8, 9]. The course of a daily activity cycle of ticks depends on abiotic factors, such as the temperature, humidity of air and hosts' activity [7, 10].

As a result of the influence of microclimate and availability of hosts, these parasites are found mainly in forest areas overgrown not only with deciduous trees, but also in coniferous forests with properly

humid and thick duff [7]. These are attractive areas for recreation and tourism, frequently visited by humans. Determination of the number of ticks which inhabit these biotopes and their seasonal activity enables an assessment of the risk of becoming infected with tick-transmitted diseases, such as: tick-borne encephalitis, borreliosis, tularemia, babesiosis, and ehrlichiosis [11-13].

Material and methods

The study was conducted in afforested areas used by the inhabitants of Olsztyn as places of leisure and recreation. Six 600 m² sites were marked out. The other five sites were marked out within the city limits and one — in the nature reserve called the Warmiński Forest, situated about 15 km from Olsztyn. The description and floristic characterisation of each site is provided in Table 1.

Ticks *I. ricinus* were caught every 10-14 days from April to October 2001 by the commonly applied method of flagging. During each catch, the temperature (T) and relative humidity (%RH) was measured with a thermohygrometer, 1 m above the duff level.

The seasonal activity of ticks in each selected area was determined by calculating the mean number of ticks caught by 1 person for 1 hour at a particular site for each month. For each site, a mean population density (number of ticks on 100 m²) and a ratio of nymphs to adult specimens (N : I), as well as the percentage of each development stage, were calculated.

Results

The location, a brief characterisation of each site and the seasonal activity, mean temperature and humidity for each month are given in Table 1. The number and percentage of each developmental stage of *I. ricinus*, the ratio of nymphs to adult ticks, and the population density (number of ticks per 100 m²) for the total catch from each site are given in Table 2. The results show that the highest activity of ticks took place at the site within the Warmiński Forest. The mean tick population density in this area was 116.8 spec. per 100 m², whereas at an average site within the city the number was 20.5 (from 12 to 29 spec. per 100 m²). A total of 701 ticks were caught at the site within the Warmiński Forest nature reserve, which accounted for 53.3% of the total catch. At all the five sites in Olsztyn a total of 614

ticks *I. ricinus* were caught. Both among the ticks caught in the Warmiński Forest and among those caught in the city, nymphs were the most common (62.6% and 93%, respectively). Larvae were not present in the catches from the sites situated within the city limits. Larvae were found only at the site situated in the Warmiński Forest in April (140 specimens) and in June (103 specimens) (Table 2).

The mean seasonal activity of *I. ricinus* at the Warmiński Forest site had two distinct peaks (Table 1). The first peak (in spring) was observed in June, while the other (in autumn) was observed in September. The activity of ticks decreased remarkably in July and August, when the mean daily temperature was above 20°C. Such distinct changes in tick activity were not observed at sites situated within Olsztyn. At most sites, only the spring peak (in June) occurred. A very high activity of ticks, both in Olsztyn and within the Warmiński Forest, took place in April (Table 1).

Discussion

This study revealed a much lower activity of ticks in a forest area within the city than in forests outside the city. The catch of ticks at the site situated in the Warmiński Forest accounted for 53.3%. At that site, two larva nests were found in April and June; they accounted for 34.7% of the total number of the caught specimens. According to Kozłowski [14] a nest is a cluster consisting only of larvae gathered together in a small area (up to 200 specimens per 0.5 m²) where a female laid eggs. The distribution and number of nests depend on shade, humidity and the thickness of duff [9]. No such nests were found at afforested sites situated within the city limits, which may mean that it is not a proper place for the parasite to develop. In a study conducted by Skotarczak et al. [15], in catches from 1997, larvae were found only at 2 of the 4 selected sites in the recreational areas of Szczecin. At a site in a seaside village of Pobierowo they accounted for 5%, and in Dobropole — for 3.8% of the total number of the parasites caught. In the spring catch of 1998, larvae accounted for 20.5% and in the spring catch — for 31.4% [16]. In the Municipal forest in Poznań, larvae were found only in spring months and they accounted for 52.2% [17]. Nymphs accounted for the majority of the catches of the quoted authors (over 50%). It was similar in this study, where the level of nymphs in the catch from the site outside the city was 62.6% and at sites situ-

Table 1. Characteristics of sites and seasonal activity of *I. ricinus* ticks in Olsztyn and the Warmiński Forest

Sampling station	Dominant species		Month*	Activity (number of ticks/ 1 person/1 hour/ 1 site)	Temperature (°C)	Air humidity (%)
	Trees	Shrubs				
Os. Mazurskie (near Skanda Lake)	<i>Acer sp.</i> <i>Quercus sp.</i>	<i>Padus sp.</i> <i>Sorbus aucuparia</i> <i>Rubus sp.</i>	A	33.2	23.7	38.5
			M	20	19.6	47.5
			J	23	19.2	65
			J	12	24.8	76
			A	12	21.6	70.5
			S	10	15	75
Pieczewo	<i>Pinus sylvestris</i>	<i>Populus tremula</i>	O	1	13	78
			A	16	26.8	35.5
			M	15	20.9	43
			J	18	20.1	71.5
			J	12	24.5	78.5
			A	9	22.7	70.5
Kortowo	<i>Fagus silvatica</i> <i>Pinus sylvestris</i> <i>Larix sp.</i>	No dominant species	S	9	14.9	76
			O	0	14.6	76
			A	25.8	24.3	36
			M	32.8	16.7	34
			J	39	18.6	66
			J	14.5	20.6	77.5
Dajtki	<i>Pinus sylvestris</i>	<i>Rubus sp.</i>	A	11	25.3	64.5
			S	11	13.5	79
			O	0	13.3	81.5
			A	58	22.3	41
			M	33	16.4	35.5
			J	54	19.2	64.5
Jakubowo	<i>Pinus sylvestris</i> <i>Picea abies</i>	<i>Corylus avellana</i> <i>Rubus sp.</i>	J	29.5	23.3	79
			A	16	24	77
			S	7	13.8	78.5
			O	0	13.9	80
			A	33	22.3	40.5
			M	40	17.5	68
The Warmiński Forest — Nature Reserve	<i>Alnus sp.</i> <i>Caprinus betulus</i> <i>Fraxinus excelsior</i>	<i>Corylus avellana</i>	J	38	19.2	35.5
			J	24.5	22.2	80.5
			A	22	24.6	72.5
			S	6	13.9	78.5
			O	8	13.8	80.5
			A	108.5	21.9	37
The Warmiński Forest — Nature Reserve	<i>Alnus sp.</i> <i>Caprinus betulus</i> <i>Fraxinus excelsior</i>	<i>Corylus avellana</i>	M	76.5	19.9	43.5
			J	164	18.7	71
			J	64	22.7	78.5
			A	37	21.7	68.5
			S	93	13.6	72.5
O	79	12.1	74			

* A — O = April — October

ated in the city it was over 90%. The levels of adult specimens varied. In this study, the level of adult specimens caught at the Warmiński Forest was low, they accounted for approx. 2% of the total, whereas in the city, adults were 6% of the caught material. In the former voivodeships of Białystok, Olsztyn, and Gdańsk, nymphs were the most common (72.2%) and the gender proportion of adult specimens was:

14.1% females and 13.7% males [18]. In catches by Nowosad et al. [17] the percentage of males and females was equal: 3.3%. In a study conducted in the afforested areas of the former voivodeship of Olsztyn, Kolpy found the number of imagines not to exceed 9.2% of the total number of caught ticks [19]. According to this author, the level of particular development forms is not a chance phenomenon,

but results from climatic conditions and requirements of such forms.

Such a large number of ticks and the presence of larvae at the site situated in the Warmiński Forest may have been the result of such factors as low daily fluctuations of temperature caused by abundant vegetation, high humidity, and the large number of hosts. The earliest forms of development — eggs and larvae — are the most vulnerable to drying [20, 21], which may be the reason why larvae were absent at the sites situated in the city, where the vegetation is scarcer. According to Wilson [22], of the several thousand eggs laid by a female, only 0.1% grows to achieve the mature stage. Of crucial importance in the non-parasitological stage are the maintaining aquatic homeostasis, the finding of a host and meeting other specimens of the same species and opposite sex, which is indispensable in the development process. The loss of water through the cuticle increases when the temperature reaches critical values. In such conditions, some physical changes occur in the lipid layer, which dramatically increase its permeability [23]. The critical temperature value is different for different development stages of ticks and reaches values similar to those for the wax covering eggs and the surface of the body of adult specimens and nymphs. According to Balashov [24] a temperature of 32°C is critical for the covering of the body of *I. ricinus*, and dramatically increases the evaporation of water from a tick body.

A study conducted in Jura Krakowsko-Częstochowska showed the distinct relationship between the number of *I. ricinus* and the degree of anthropogenic pressure [25]. Apart from the above environmental factors, the number of ticks in the environment is significantly affected by noise, car

fumes and other contaminants linked to human industrial activity. This also results in the reduction of land vertebrates, which are hosts to the parasites, thereby reducing the number of ticks. These factors were the probable cause of a low activity of ticks at the sites situated within the city. On the other hand, the large number of ticks caught in the nature reserve of the Warmiński Forest resulted from the parasites' easy access to their hosts.

In all areas under study, a high activity of ticks was observed in April. The exceptionally high temperature probably caused it at the time. According to Buczek and Magdoń [26], an increase in the temperature in spring pushes the hungry specimens to search for food. Those which were active in autumn and had fed enough went through moulting and, having lived through winter, became active as early as in April. Apart from the high activity in April, a spring peak in June and in September were observed at the Warmiński Forest site. At the sites situated in the city, one peak of activity was observed namely in June. This is consistent with the Kolpy's observations [27], who claims that the autumn peak of activity is absent after a hot summer. According to the previous publication of the above-mentioned author, the precise starting dates of tick seasonal activity vary even within a site [8]. In the authors' own study conducted in the City Forest in Olsztyn, at the majority of sites one spring peak of activity was observed in May, whereas the autumn peak was observed only at the sites situated deep in the forest and was less distinct [28].

In Redykajny (a district of Olsztyn) [8, 27] the spring peak in May and the autumn peak in September were recorded. In the north-eastern Poland Wegner et al. [18] recorded the spring peak

Table 2. The number and percent (n/%) of the particular developmental stages of *I. ricinus* ticks in catches from the particular sites.

Sampling station	Developmental stages				Total number of ticks n	N:I*	Abundance (number of ticks /100m ²)
	n/%		Females	Males			
	Larvae	Nymph					
Os. Mazurskie	0/0	91/92	5/5	3/3	99	11.4	16.5
Pieczewo	0/0	67/93	5/7	0/0	72	13.4	12.0
Dajtki	0/0	112/92	5/4	5/4	122	11.2	20.3
Kortowo	0/0	163/93	6/4	5/3	174	14.8	29.0
Jakubowo	0/0	141/96	2/1.5	4/2.5	147	23.5	24.5
Total for urban places	0/0	574/93	23/3.7	17/2.7	614	14.35	20.5
The Warmiński Forest	243/34.7	439/62.6	10/1.4	9/1.3	701	23.1	116.8

* the nymphs to adults (imago) proportion

in May (former voivodeships of Białystok and Gdańsk) and in June (the former voivodeship of Olsztyn). The autumn peak was recorded in August in the former voivodeships of Olsztyn and Gdańsk and in September in the former voivodeship of Białystok. In the studies by the above authors and in own research, the lowest activity of ticks was observed in summer months when the temperature is the highest.

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