

PRELIMINARY STUDIES ON THE RELATIONSHIP BETWEEN *IXODES RICINUS* ACTIVITY AND TICK-BORNE INFECTION AMONG OCCUPATIONALLY-EXPOSED INHABITANTS OF EASTERN POLAND

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Abstract: Relative density (activity) of the tick *Ixodes ricinus* was determined in five districts of the Lublin region (eastern Poland) by vegetation flagging. Tick activity values were compared to the determined by ELISA tests seroprevalence to tick-borne encephalitis virus (TBEV) and *Borrelia burgdorferi* in forestry workers and farmers from the same areas. A significant correlation between tick activity and seroprevalence to both TBEV and *B. burgdorferi* antigen was found in farmers and in the total examined population.

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INTRODUCTION

Tick-transmitted diseases create a serious epidemiologic and clinical problem, especially in the working environment in forestry and agriculture. In Poland, the main risks are represented by the tick-borne encephalitis virus (TBEV) and *Borrelia burgdorferi sensu lato* (agent of Lyme borreliosis), transmitted by the ticks *Ixodes ricinus* which are widespread in Europe [7, 13, 16, 21]. The annual incidence of borreliosis in Poland reveals a growing tendency from 751 in 1996 to 891 in 1999, most of them in eastern Poland [2]. The annual incidence of TBE in Poland was 101 in 1999 [2]. Infections are common among people occupationally exposed to tick bites (forestry workers, farmers, rambles, mushroom and berry pickers) [6, 12, 19].

High *Ixodes ricinus* activity may result in a growing risk of tick-transmitted diseases, especially in the forestry and agricultural working environments [1, 3, 12, 19].

Unfortunately, the data concerning the rhythms of activity of the tick *Ixodes ricinus* in Poland are still incomplete; so far, data are available only for several hundreds localities [10, 11, 15, 20].

The aim of the study was to determine the activity of *Ixodes ricinus* population in five districts in the Lublin region (eastern Poland) and to compare this activity to the results of seroepidemiologic study on tick-transmitted diseases in people occupationally exposed to tick bites.

MATERIALS AND METHODS

Ixodes ricinus unfed adults and nymphs were collected by flagging the lower vegetation [8, 11, 20] of peripheral areas and inner parts of woods every two weeks from April–October in the years 2000–2001. The relative density of active ticks was determined as a mean number of ticks collected per one person during one hour, on one site and assumed to be equivalent to the term “tick

activity". The ticks were collected in five districts of the Lublin region (number of sites/1 h determinations of relative density are given in parentheses): Parczew (4/12), Kraśnik (5/9), Lublin (6/14), Zamość (5/9), Włodawa (2/5). A total of 49 determinations of relative density of active ticks at 22 sites were carried out. Forestry workers and farmers inhabiting the same districts of the Lublin region where ticks were collected were earlier examined for the presence of specific anti-TBEV and anti-*Borrelia burgdorferi* antibodies. A total of 303 forestry workers and 291 farmers were examined for the presence of anti-TBEV antibodies, while 241 forestry workers and 289 farmers were examined for the presence of anti-*B. burgdorferi* antibodies. The serological examination was carried out by ELISA test using "Enzygnost Borreliosis" (Behring, Germany) IgG and IgM commercial kits for detecting anti-*B. burgdorferi* antibodies and FSME IMMUNOZYME IgG kit produced by Immuno (Austria) for detecting anti-TBEV antibodies. The tests were performed as described previously [1, 3]. The significance of the correlation between tick activity and seroepidemiological findings was tested by the non-parametric Spearman R-test. The p-value less than 0.5 was considered significant. The analyses were performed with the use of Statistica for Windows 4.5 package (Statsoft©, Inc., Tulsa, Oklahoma, USA).

RESULTS

The results are summarised in Table 1. A significant correlation between the tick activity and seroprevalence to both TBE-virus and *Borrelia burgdorferi* antigen was found in the group of farmers and in the total examined

population of occupationally-exposed people (farmers and foresters) ($p < 0.05$). Nevertheless, no significant relationship could be found between the tick activity and percentages of antibody response to the aforementioned antigens in the group of forestry workers.

The relationship between the tick activity and frequency of seropositive reactions to tick-borne agents in examined population was best seen in Kraśnik district where an extremely low value of tick activity (7.6) was accompanied by the lowest prevalence of seropositive reactions with both antigens and in all examined groups. With increasing activity, an increased frequency of positive reactions was also observed among farmers but not among forestry workers. In Lublin district, where the highest value of tick activity was noted (44.0) the highest antibody response of the farmers to TBEV and *B. burgdorferi* was also observed, whereas the antibody response of forestry workers was in the mid-range. The second highest value of tick activity (Zamość district, 31.6) was accompanied as well by high values of seropositive reactions in farmers.

DISCUSSION

The studies on *Ixodes ricinus* activity were conducted both in Poland and abroad [4, 10, 11, 15, 20] but there are only a few publications describing the relationship between the relative tick density and *Borrelia* and/or tick-borne encephalitis virus infections in humans. Stafford *et al.* [17] demonstrated the significant correlation between the high *Ixodes scapularis* activity, prevalence of ticks infected with *Borrelia burgdorferi* and increasing number of Lyme borreliosis in the state of Connecticut, USA.

Table 1. Relationship between activity of *Ixodes ricinus* ticks and frequency of seropositive reactions to tick-borne infectious agents among occupationally exposed foresters and farmers.

District	Relative density of active <i>I. ricinus</i> ticks ^a	Number of persons showing the presence of antibodies to antigens of infectious agents transmitted by ticks (positive reactants/total examined, percent)					
		Forestry workers		Farmers		Total (forestry workers + farmers)	
		TBEV ^b	<i>Borrelia burgdorferi</i>	TBEV	<i>Borrelia burgdorferi</i>	TBEV	<i>Borrelia burgdorferi</i>
Parczew	30.6	33/64 (51.6%)	13/64 (20.3%)	19/100 (19.0%)	29/100 (29.0%)	52/164 (31.7%)	42/164(25.6%)
Kraśnik	7.6	6/42 (14.3%)	6/41 (14.6%)	6/39 (15.4%)	3/37 (8.1%)	12/81 (14.8%)	9/78 (11.5%)
Lublin	44.0	6/26 (23.1%)	6/29 (20.7%)	40/60 (66.7%)	31/60 (51.7%)	46/86 (53.5%)	37/89 (41.6%)
Zamość	31.6	34/108 (31.5%)	17/44 (38.6%)	18/32 (56.2%)	11/32 (34.4%)	52/140 (37.1%)	28/76 (36.8%)
Włodawa	28.0	8/63 (12.7%)	17/63 (27.0%)	13/60 (21.7%)	17/60 (28.3%)	21/123 (17.1%)	34/123 (27.6%)
Median	30.6	23.1%	20.7%	21.7%*	29.0%**	32.7%**	27.6%*
Mean ± SD	28.4 ± 13.1	87/303 (28.7 ± 15.9%)	59/241 (24.5 ± 9.1%)	96/291 (33.0 ± 23.8%)	91/289 (31.5% ± 15.6%)	183/594 (30.8 ± 15.8%)	150/530 (28.3 ± 11.6%)

^aMean number of *Ixodes ricinus* ticks collected per one person during one hour, at one site (mean). ^bTBE: tick-borne encephalitis. *--*: frequency of seropositive reactions in particular districts significantly correlated with the activity of *Ixodes ricinus* ticks; * $p < 0.05$, ** $p < 0.01$.

Naumow [9] concluded that infection with *Borrelia burgdorferi sensu lato* increases the questing activity of the taiga tick *Ixodes persulcatus*. Such a relationship has not been confirmed by Petko *et al.* [11] with respect to *Ixodes ricinus* ticks collected in southern Poland.

Süss *et al.* [18] compared the abundance of *I. ricinus* ticks and incidence of TBE cases in six districts of Germany. In one district, a high abundance of ticks was accompanied by a large number of TBE cases.

So far in available literature we have not found any epidemiological analyses comparing tick activity and seroprevalence of tick-borne diseases in humans. Similar analyses concerning the relationship between tick exposure factors and seroprevalence of tick-borne diseases in domestic animals have been presented by Egenvall *et al.* [5] with respect to equine borreliosis and ehrlichiosis in Sweden and by Sahibi *et al.* [14] with respect to bovine babesiosis in Morocco.

The results of this preliminary study suggest that tick activity may be significantly correlated with the seroprevalence of TBE and Lyme borreliosis in occupationally-exposed people. It is noteworthy that this relationship was found foremost in farmers.

In eastern Poland, the area of this study, many farms are situated in the vicinity of deciduous or mixed forests and farmers may be exposed to attack by ticks questing on lower vegetation at the edge of forests and cultivated fields. Though we cannot at present explain the reason for the stronger relationship between tick activity and the seroprevalence of tick-transmitted diseases in farmers compared to forestry workers, it cannot be excluded that a more abundant occurrence of ticks on the edge compared to inner parts of forest - observed by us - may be one possible reason.

The results obtained indicate a propriety for further studies of the presented relationship, including determining of the infection ratio of ticks with *Borrelia burgdorferi* and TBEV.

To summarize, the hitherto obtained results suggest that determining of tick activity may be useful, at least to some extent, for the prediction of TBEV and *Borrelia* infection rate in humans, in particular in farmers.

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