INTRODUCTION

Ticks are common human and animal parasites producing a variety of symptoms associated with the harmful effects of components of their saliva [9, 11, 14, 28] and with transmission of numerous pathogens of tick-borne diseases [6, 63, 73]. Due to their wide distribution in different types of habitats, they represent a major threat to hosts' health. Man may be infested by various species of ticks [45, 79], but more than 12 argasid and 20 ixodid tick species that feed on domestic and wild living animals are usually found attached to the skin of humans [29]. In Europe, the common tick species *Ixodes ricinus* [20, 38] parasitises humans most frequently [58].

Most literature data indicate the role of *I. ricinus* in the transmission of pathogens: viruses [18, 35, 46, 65], bacteria [13, 41, 43, 59, 65, 74, 75, 76] and protozoa [13, 36, 64, 70, 75, 81]. The direct effects of tick parasitism on humans have rarely been reported [28, 57, 61].
This paper presents the results of examinations of tick-infested patients admitted to health care facilities from two popular tourist areas in the Lublin province. Furthermore, in order to estimate the degree of risk of tick attack and tick-borne diseases, we assessed the density of ticks in localities that are frequently visited by humans for occupational or recreational reasons.

**MATERIALS AND METHODS**

**Study area.** The study was conducted in the years 2003–2005 in two typically agricultural parts of the Lublin province, which are also a recreational region for the inhabitants of south-eastern Poland. In the south of the province, the study area included Roztocze, covered by forests in 2/3 of its area. Pine is the dominant species in the forests, accompanied by fir and Carpathian beech. There are water reserves in the valleys of the rivers Wieprz, Solska and Opornica, and numerous marshes and bogs in Solska Primeval Forest. In the north of the province, there are two large forest complexes, i.e. Parczewskie Forest and Kozłówkie Forest. The former is a pine coniferous and mixed forest. Additionally, there are alder, hornbeam-oak and riparian forest communities. In the neighbourhood of the forested areas, there are fishponds, lakes, forest meadows and cultivated fields. The Kozłówkie Forest consists of lowland mixed forests: old pine stands with the addition of oak, aspen, hornbeam, linden, and spruce.

**Collection of ticks.** Ticks were collected using the flagging method in May 2003 and 2004, i.e. during the spring peak of seasonal activity of *Ixodes ricinus* and *Dermacentor reticulatus* in areas frequently visited by locals and tourists in the southern and northern parts of the province. In order to determine the real threat of tick attacks, tick density was determined in the study area (number of specimens collected with the use of one flag during one hour). The method applied facilitates collection of all stages of *I. ricinus* and adult forms of *D. reticulatus*. However, in the case of *I. ricinus*, the collection was only focused on the tick stages that attack humans most frequently, i.e. nymphs and adults. The tick specimens were transferred to 70% ethyl alcohol, and their species and developmental stage were determined in laboratory conditions.

**Examination of the effects of tick bites.** The study involved patients from four health care facilities in the southern and northern parts of the Lublin province, referred to a doctor due to symptoms appearing upon bites of parasitic arthropods. Epidemiological interviews were conducted with each of the 184 patients in order to obtain information about their occupation as well the location and time of tick attacks. Additionally, skin lesions produced by tick infestations were identified. Physical examination was conducted in patients with skin and systemic symptoms.

Since in most cases patients reported to the doctor after removal of ticks, it was impossible to identify the developmental stage that had infested them.

**RESULTS**

Two species of ticks – *I. ricinus* and *D. reticulatus* – were identified in the tick collections. In the southern part of the Lublin province, specimens of *I. ricinus* only were collected, whereas in the north specimens of both species were found (Tab. 1). The forest complexes in the study area were dominated by of nymphs and adult *I. ricinus*, while adult *D. reticulatus* were predominant on the meadows. Depending on the locality, the density of *I. ricinus* nymphs and adults ranged from 18.5–42 specimens/1 hr of collection. In the case of adult *D. reticulatus*, the density was in the range of 19.5–64 specimens/1 hr of collection.

**Table 1.** Number of active *Ixodes ricinus* and *Dermacentor reticulatus* ticks collected in sites located in southern (A) and northern (B) parts of Lublin province in 2003–2004.

<table>
<thead>
<tr>
<th>Site</th>
<th>Totala</th>
<th>Mean tick densityb</th>
<th>F</th>
<th>M</th>
<th>N</th>
<th>Total</th>
<th>Mean tick densitya</th>
<th>F</th>
<th>M</th>
</tr>
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<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>A Solska Primeval Forest (Józefów area)</td>
<td>111</td>
<td>18.5</td>
<td>50</td>
<td>36</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roztoczański National Park (Zwierzyniec area)</td>
<td>104</td>
<td>26</td>
<td>43</td>
<td>37</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B Parczewskie Forests (Sosnowica area)</td>
<td>100</td>
<td>25</td>
<td>25</td>
<td>15</td>
<td>60</td>
<td>78</td>
<td>19.5</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>Łęczyńska-Włodawskie Lakeland (Stary Ulcinów area)</td>
<td>5</td>
<td>2.5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>128</td>
<td>64</td>
<td>87</td>
<td>41</td>
</tr>
<tr>
<td>Kozłówkie Forests (area of Majdan) Kozłówkiei</td>
<td>84</td>
<td>42</td>
<td>36</td>
<td>37</td>
<td>11</td>
<td>42</td>
<td>22</td>
<td>39</td>
<td>3</td>
</tr>
</tbody>
</table>

* – total number of collected ticks; † – average number of ticks collected with one flag during 1 h of collection; F – females; M – males; N – nymphs.
As many as 184 (44%) patients out of the 418 people seeking medical assistance after attacks of arthropods had been bitten by ticks. The group consisted of 109 women and 75 men. Most patients (32.5%) were manual workers – farmers, forest workers, hunters and horticulture farmers, i.e. workers that are occupationally exposed to tick attacks. A considerable proportion of people attacked by arthropods included white-collar workers (21.2%), students (17.1%), workers employed in various firms and working on their own farms (16.3%), and pensioners (11%). Children constituted only 1.9%.

The patients reported tick bites in the period from April (0.6%)–September (7.8%). However, most cases of tick infestations in humans were reported in July (45%), June (23.3%) and August (19.4%).

Ticks attacked humans in various habitats (Tab. 2). In as many as 78.7% of the cases, the arthropod attacks took place in forests and over two-fold less often (31.3% of the cases) in other places, such as meadows, orchards, parks, farmlands and private estates.

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The most common sites of tick bites were upper and lower extremities, 28.8 and 27.1%, respectively. In a lower percentage of the patients, the ticks attached to on the abdomen, head and back, and in individual cases, on the chest and neck (Fig. 1). 77.7% of the patients exhibited symptoms after tick infestations. As many as 57.6% of the patients, including 33.1% of women and 24.5% of men, developed local skin lesions. The incidence of combined local and systemic symptoms was similar in the groups of men and women. No symptoms after tick bites were reported in 22.3% of the cases, the percentage in women being three-fold higher than in men (Tab. 3).

Erythema (66.8%) and pruritus (50%) were the most commonly found local skin symptoms. Additionally, the patients complained of pain, tingling, or burning sensation at the site of the bite (Fig. 2). Headache was the predominant systemic symptom (10.8% of the patients). Significantly fewer patients reported inflammation of the lymph nodes, increased body temperature and pain in the joints (Fig. 3).
DISCUSSION

Studies indicate a high level of risk of tick attacks to humans and animals in the agricultural and recreational regions of the Lublin province. This is confirmed by both field studies demonstrating a high density of *I. ricinus* and *D. reticulatus* and numerous reports of local and systemic symptoms in humans caused by parasitic ticks. A great number of environmental factors can be responsible for the differences in the tick density in the Lublin province found in our study and studies of other authors [17]. These factors include topography, the vegetation structure ensuring presence of tick hosts, humidity and temperature conditions, and climatic changes [8, 30, 33, 40]. Many populations of *I. ricinus* were also found in other recreational areas around Poland [10, 60, 74, 80] and Europe [22, 32, 34, 39, 51]. Like other authors [48, 50, 72, 79], we found that the density of *I. ricinus* ticks in dense, humid mixed forests (Kozłówwieckie and Parczewskie Forests) was higher than that in coniferous forests (Solska Primeval Forest). In this type of biotope, there is the highest probability of infection with the tick-borne encephalitis virus and *Borrelia burgdorferi* spirochetes [20, 21]. However, there is not always a correlation between *I. ricinus* tick density and the degree of their infection with pathogens [31]. Transmission of pathogens is determined by the activity of animals – ticks’ hosts – inhabiting the biotope [26, 42, 56, 60, 68, 71]. In our study area, a high rate of infection of *I. ricinus* ticks with pathogens was found; depending on the habitat and study period, it was in the range of 5.3–15.1% for *B. burgdorferi* [69], 0.7–28.1% for *Anaplasma phagocytophilum* [15, 82] and 1.8–4.2% for the tick-borne encephalitis virus [18]. The highest density of adult *D. reticulatus* was found in typical habitats for this species, i.e. in meadows (Łęczyńsko-Włodawskie Lakeland) and in mid-forest clearings of the Parczewskie Forest. This species is widespread in eastern Poland [25, 27, 53, 72].

Our study suggests that human behaviour has a significant impact on the incidence of tick bites. Staying in tick habitats during their seasonal activity for occupational or recreational purposes increases the risk of arthropod attack. In our research, the largest numbers of tick bites were reported from June–August, i.e. in the period of field and forest work, and during recreational activities in forests, meadows and parks.

The cases of tick bites in the group of elderly people (pensioners) found in our study may be associated with both recreation and the need to collect forest groundcover products for commercial gain, which is necessitated by the deterioration socioeconomic condition in this part of Poland. In 2008, the indicator of material deprivation (at least three of the nine symptoms of poverty taken into account) in the European Union was 17%, while in Poland 32% – nearly twice the average of the European Union. Most Polish people at risk of income poverty live in the Lublin province [37].

As in our study reporting the highest incidence of skin lesions and systemic symptoms appearing upon tick bites in manual workers, other authors [5, 12, 23, 77] observed high rates of infection with tick-borne pathogens among forestry workers and farmers exposed to direct contact with ticks. In the Lublin province, seropositive test results indicating presence of *B. burgdorferi* in serum were obtained in ca. 40% of forest workers [19]. *A. phagocytophilum* bacteria were detected in 20.6–33.3% [16, 78], and tick-borne encephalitis viruses in 14.8–53.5% of forestry workers and farmers [17]. In the provinces of Malopolska and Silesia (southern Poland), the percentage of positive results of anti-*Borrelia burgdorferi* antibodies in IgM class ranged from 7.5–25.0%, while for the IgG class it was 16.3–29.1% [12]; in Lower Silesia (western Poland) it was 35.0% [24] and in West Pomerania 35–61.9% [62]. The high incidence of infection with *B. burgdorferi* spirochetes in forestry workers and other workers occupationally exposed to tick bites was found in neighbouring countries, namely in Germany – 30% [66] and Slovakia – 12.8% [4]. In France, the presence of anti-*Borrelia burgdorferi* antibodies was confirmed in 14.1% [77], in Turkey in 10.0% [54] and in Italy in 7.5% of people occupationally exposed to tick attacks [67].

Our current as well as previous observations show that the places on adult human skin most preferred by *I. ricinus* ticks are the extremities and the abdomen [1]. Also, according to other studies by Hügli *et al.* [49], the legs were the major anatomical sites of bites for women (40.7%), men (44.4%), and almost all age groups.

The inconsiderable number of tick bites in children in the Lublin province makes it impossible to determine the most common tick-feeding sites in patients from this age group. In our study, we found an asymptomatic case of attachment of *D. reticulatus* female to human skin. Although this tick species most commonly infests domestic and wild animals, it plays an important epidemiological role in circulation of pathogens that cause human diseases [47, 55, 83].

In the examined patients, the most common local symptom induced by components of *I. ricinus* saliva was erythema appearing in the bite site. The incidence of combined local and systemic symptoms was three-fold lower than that of local symptoms. In the tick bitten patients, we did not perform serological tests for antibodies against pathogens transmitted by ticks; therefore, we cannot exclude the possibility of infection by bacteria or viruses, the symptoms of which in the first phase are similar to those observed in our study [3, 7, 44, 52]. Skin lesions and systemic symptoms may not be present in a large percentage of patients bitten by ticks. It is difficult to explain unambiguously the higher proportion of asymptomatic cases found in women in our study. It is likely to result from increased women’s outdoor activity (e.g. fieldwork, haymaking, collecting forest groundcover fruit), and their higher exposure to arthropod bites. Our group consisted of patients reporting bites of a variety of arthropods (black flies, biting midges).
Although eastern and south-eastern Poland is an area of high risk of tick attacks and infections by tick-borne pathogens, residents’ knowledge of the principles of tick prophylaxis is insufficient [2]. The high density of ticks in recreational and agricultural areas demands that residents and should pay attention to the consequences of tick parasitism and the medical services promote prevention methods.

Acknowledgements

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