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CLIMATE AND ENVIRONMENTAL FACTORS INFLUENCING *ECHINOCOCCUS MULTILOCULARIS* OCCURRENCE IN THE SLOVAK REPUBLIC

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Abstract: During the period of 2000-2004, 3,096 red foxes from the whole territory of the Slovak Republic were sampled and examined parasitologically for infections with *Echinococcus multilocularis*, causative agent of serious alveolar echinococcosis in humans. Relations between prevalence of the parasite in individual regions of Slovakia and some environmental factors were weighted. During the study period, great differences of prevalence and infection intensity were found on a regional level and significant between-year fluctuation of both parameters was observed. High-endemic foci with an estimated prevalence of more than 30% were detected in the northern and central part of the country. Climatic conditions, including low mean annual air temperature, high mean annual rainfall and the high humidity of the soil, showed to be important for *E. multilocularis* distribution. Significant correlation was calculated between prevalence of the tapeworm, mean annual precipitation values, and population density of small mammals.

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Key words: climatic conditions, *Echinococcus multilocularis*, environmental factors, Slovak Republic, *Vulpes vulpes*.

INTRODUCTION

Echinococcus multilocularis tapeworm, a causative agent of serious alveolar echinococcosis, has become the object of intensive research in Europe with an increasing number of infections in humans already in early 90's of the 20th century, first of all in Western Europe [25]. In Central Europe, the life cycle of *E. multilocularis* is predominantly sylvatic, involving mainly the red fox (*Vulpes vulpes*) as definitive host and rodents as intermediate hosts [23]. According to Directive No. 2003/99 ES of European Parliament and EU Council on monitoring of zoonoses and their causative agents, alveolar echinococcosis was classified into category "A", requiring permanent monitoring of its occurrence in all EU member states.

E. multilocularis in Central Europe was detected for the first time in red fox in 1995 in the north of Poland [17] and southern and western districts of the Czech Republic [10, 19]. Only after the parasite was found in neighbouring countries was targeted examination of red foxes started in Slovakia. The first finding of *E. multilocularis* on the territory of Slovakia was recorded in 1999 [3]. Since this finding, detailed epidemiological survey of the parasite in Slovakia has been initiated. The main aims of this monitoring were to determine prevalence rate and infection intensity of *E. multilocularis* in red foxes, and to identify potential risk areas and critical environmental factors influencing the disease distribution.

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Table 1. Ecological characteristic of the regions in the Slovak Republic.

	South-western			South-eastern	North-western		North-eastern	Central
	Bratislava (BA)	Trnava (TT)	Nitra (NR)	Košice (KE)	Trenčín (TN)	Žilina (ZA)	Prešov (PO)	Banská Bystrica (BB)
Climatic region	warm, very dry	warm, very dry	warm, very dry	warm, dry-moderately humid	warm-moderately warm, moderately humid-very humid	moderately cool-cool mountainous	moderately warm-moderately cool, humid-very humid	warm-moderately cool, moderately humid
Mean annual air temperature (ºC)	10-11	9-12	10-12	8-10	8	4-6	6-8	8-9
Mean annual precipitation totals (mm)	500-680	500-680	500-700	450-650	600-900	900-1,300	700-900	600-900
Mean annual temperature of active soil surface (ºC)	10-12	10-12	10-12	10-11	6-8	3-6	5-7	8-10
Soil moisture regime (humidity)	slightly dry-slightly moist	slightly dry-slightly moist	slightly dry-slightly moist	slightly moist	slightly moist	moist	slightly moist-moist	slightly moist-moist
Soil texture class	sandy, loamy-sandy	sandy-loamy, loamy	clay-loamy, clay	clay-loamy, clay	loamy	loamy	loamy	loamy
Mean annual values of radiation index of drought	1.45	1.50	1.50	1.00-1.54	0.75-1.28	0.50-1.00	0.47-1.08	0.80-1.50

MATERIAL AND METHODS

Study area and samples collection. The study area is whole territory of the Slovak Republic that covers 49 034 km^2, and is situated between 47º44'-49º31' N and 16º51'-22º30'E in Central Europe; surrounded by the Czech Republic in the northwest, Poland in the north, Ukraine in the east and Hungary and Austria in the south. It belongs to the moderate climatic zone with a mean annual air temperature of 10ºC, and is considered to be European country with the most rugged topography. Climate and geomorphologic conditions differ a lot in individual regions. Data of ecological characteristics of surveyed areas were obtained from a digital version of the Landscape Atlas of the Slovak Republic, listed in Table 1. Northern regions (Trenčín, Žilina and Prešov) and mountainous parts of central region (Banská Bystrica) are distinguished by low mean annual air temperature (4.0-8.8ºC), high mean annual rainfall (800-1,330 mm) and high humidity of the soil. Forests and pastures occupy the largest part of this territory. Agricultural land is the predominant landscape in southern regions (Bratislava, Trnava, Nitra and Košice). This part of Slovakia is characterized by high mean annual air temperature (10.0-12.0ºC) and low mean annual precipitation values (430-680 mm). The Slovak Republic is administratively divided into 8 regions and 79 districts.

Between 2000-2004, a total of 3,096 red foxes that originated from 78 districts and all regions of Slovakia were examined for *Echinococcus multilocularis* presence. The monitoring was divided into 2 periods: a detailed survey in whole territory was performed from 2000-2002 [18]; in the years 2003 and 2004 red foxes from selected regions of northern and southeastern Slovakia were investigated. The animals were hunted for a control of the effect of anti-rabies vaccination carried out twice a year in the spring/summer (May/June) and autumn/winter (November/December) season. The capture site of hunted foxes was determined according the cadastral number, and carcasses were transported to the State Veterinary and Food Institute for rabies examination. Small intestines and faeces of foxes negative for rabies were removed, wrapped in plastic bags and frozen at -20ºC. All samples were then delivered to the Parasitological Institute SAS and deep-frozen at -80ºC for at least 7 days prior to examination in order to reduce risk of infection.

Methods. Sedimentation and counting technique (SCT) was used for *E. multilocularis* detection [22]. *E. multilocularis* worms were identified following morphological criteria of Vogel [37] and Thompson [35]. In cases when small intestines of red foxes were not available, copro-antigen of *Echinococcus* spp. were detected by an ELISA in their faeces for evidence of tapeworm. A commercial ELISA kit (Checkitâ-Echinotest, Dr. Bommeli AG, Switzerland) was used for the purpose. The preparation of faecal samples and estimations of coproantigen level were carried out according to the instructions of the manufacturer.

Two fundamental epidemiological characteristics were evaluated in the areas surveyed: prevalence and worm burden (infection intensity). Non-parametrical test (Chi-square test with Yates correlation) was used for statistical comparisons [33].

Influence of 3 environmental factors (mean annual air temperature, mean annual precipitation and relative density of small mammals) on *E. multilocularis* prevalence rate and mean worm burden in red foxes was assessed. The data on climatic factors in individual years investigated were obtained from datasets by the Slovak Hydrometeorological Institute.

The relative density data of small mammals' population were received from the Zoological Institute SAS. The trappings of small mammals were carried out in 2 areas of southern (Košická Kotlina Plain, Cadastres: Rozhanovce, Košice, Kechnec) [32] and northern Slovakia (Pieniny Mountains, Cadastres: Vyšný Lipník, Červený Kláštor) twice a year during spring and autumn. Small mammals were trapped by standard snap traps. Traps were laid in lines of 50, spaced 5 m apart. A wick soaked with oil and nut mixture was used as bait. Each line was usually exposed for 2 nights. Trap lines were checked regularly each morning. The relative density was expressed as number of animals per 100 traps/nights.

Simple correlation coefficients were calculated to determine any noticeable relationships between prevalence and infection intensity of *E. multilocularis* in red foxes and mentioned environmental factors [33].

RESULTS

Between-year fluctuation and regional differences in prevalence and infection intensity. Over a period of 5 years, 3,096 red foxes from whole territory of the Slovak Republic were sampled and examined for intestinal infections with *E. multilocularis*. Of these, 911 (29.4 ± 7.8%) were infected. An overall map shows that red foxes from all districts, excepting one, have been investigated and *E. multilocularis* currently occurs in the most of them (Fig. 1). The parasite has been not found in only 4 districts of western Slovakia. During the study period great differences of prevalence and infection intensity were found on a regional level. Also significant between-year fluctuation of both parameters observed was recognized.

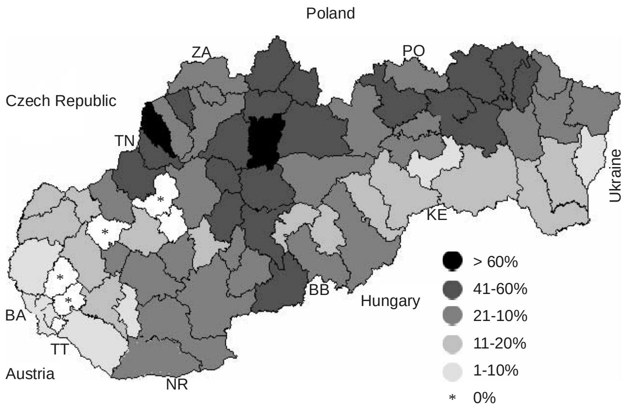

Figure 1. Mean prevalence rates of *Echinococcus multilocularis* in individual districts and regions of the Slovak Republic in 2000-2004 (Regions: BA-Bratislava, TT-Trnava, NR-Nitra, BB-Banská Bystrica, TN-Trenčín, ZA-Žilina, PO-Prešov, KE-Košice).

During the first year of the monitoring in 2000, a total prevalence of *E. multilocularis* recorded in the Slovak Republic was 24.8 ± 9.6% (164 of 662) (Tab. 2). In the following year, the prevalence increased to 33.9 ± 20.6% (226 of 666) and in 2002 maintained around the same

Table 2. Prevalence of *Echinococcus multilocularis* in red foxes in individual regions of the Slovak Republic.

Surveyed periods	South-western		South-eastern		North-western		North-eastern	Central	Slovak Republic
	Bratislava (BA)	Trnava (TT)	Nitra (NR)	Košice (KE)	Trenčín TN)	Žilina (ZA)	Prešov (PO)	Banská Bystrica (BB)	
spring/summer 2000	25.0	14.3	27.2	10.5	0	27.3	22.1	35.7	26.8±10.6
autumn/winter 2000	0	12.0	12.2	13.0	35.0	50.0	27.7	29.0	22.7±15.0
year 2000	11.1	13.2	17.9	12.3	29.2	38.1	24.1	32.9	24.8±9.6
spring/summer 2001	0	18.7	17.0	12.3	62.5	73.9	50.8	14.5	30.5±25.4
autumn/winter 2001	0	12.5	31.4	20.0	36.8	50.0	61.2	31.7	36.8±18.5
year 2001	0	16.7	25.6	21.1	48.6	64.1	56.9	23.9	33.9±20.6
spring/summer 2002	0	8.3	36.4	17.5	31.4	59.3	37.1	30.4	29.9±17.4
autumn/winter 2002	11.1	31.0	28.4	19.6	38.3	79.2	51.6	32.2	35.0±19.7
year 2002	5.0	20.8	30.7	18.5	35.4	68.6	44.4	31.5	32.8±17.8
spring/summer 2003	0	5.0	-	13.0	25.0	28.6	26.1	-	22.1±11.0
autumn/winter 2003	0	0	-	11.9	30.8	32.1	35.0	-	21.8±14.9
year 2003	0	2.1	-	12.1	28.6	31.0	30.1	-	21.9±13.1
spring/summer 2004	-	-	-	10.9	16.7	9.1	19.6	-	13.8±4.3
autumn/winter 2004	-	-	-	18.3	50.0	66.7	56.2	-	41.2±18.1
year 2004	-	-	-	16.0	38.9	37.9	45.9	-	32.3±11.2
Total 2000-2004	3.3±8.6	13.0±8.8	25.3±8.3	16.2±3.5	36.7±16.2	47.5±21.7	39.3±14.4	29.7±6.8	29.4±7.8

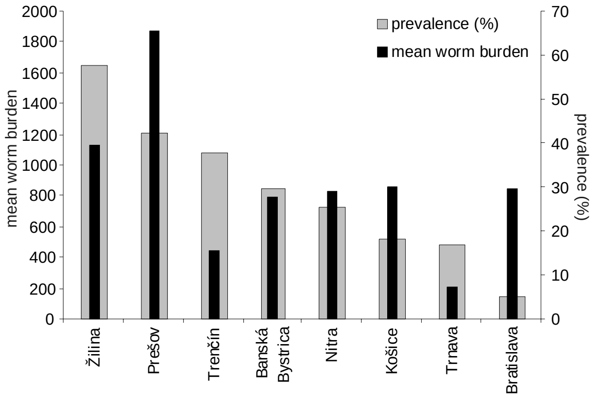

Figure 2. Relation between prevalence and mean worm burden of *Echinococcus multilocularis* in individual regions of the Slovak Republic in 2000-2002.

level-32.8 ± 17.8% (263 of 802). The growth of prevalence between 2000-2001 was statistically significant (Chi-square test χ^2 = 28.2598; df = 7; p ≤ 0.001). In 2000-2002, the highest prevalence of *E. multilocularis* in red foxes was recorded in the northern part of the country - in Žilina, Prešov and Trenčín region and the mountainous area of the central Banská Bystrica region. In several districts of these regions, prevalence reached more than 60%. During the first period of monitoring, also the highest mean worm burden of *E. multilocularis* was recorded in regions with the highest prevalence rates (Prešov and Žilina region), i.e. in the north-eastern and north-western parts of Slovakia, respectively. Dependence between mean worm burden and prevalence is illustrated on Figure 2.

In 2003 a total of 520 red foxes from 6 regions of Slovakia were examined, and a significant decrease of *E. multilocularis* prevalence in the selected regions in red foxes was recorded (21.9 ± 13.1%) (Chi-square test χ^2 = 13.9334; df = 5; p ≤ 0.025) (Tab. 2). The highest prevalence rate was again found in the northern part of Slovakia (Žilina region), but its value decreased in more than 50%. The mean worm burden also declined from 1068 in 2002 to 537 tapeworms in 2003 (Tab. 3).

During the spring/summer period of 2004, only 20 of 145 (13.8 ± 4.3%) red foxes were infected with *E. multilocularis* (Tab. 2). In endemic areas of Žilina and Prešov regions, prevalence reached only 9.1% and 19.6%, respectively. Surprisingly, in the second half of the year 2004, prevalence rapidly increased to 41.2 ± 18.1% (124 of 301) in 4 sampled regions of Slovakia (Chi-square test

Table 4. Simple correlation coefficients between prevalence and mean worm burden of *Echinococcus multilocularis* in red foxes and variables of candidate environmental factors.

Environmental factor	Prevalence (r)	Infection intensity (r)
Mean annual air temperature	-0.382	-0.297
Mean annual precipitation	0.933*	0.973*
Relative density of small mammals	0.709*	0.166

* p<0.05

χ^2 = 9.1266; df = 3; p ≤ 0.05). The highest prevalence (45.9%) was recorded in Prešov region of northeastern Slovakia. In 2004, also a large increase in infection intensity was recorded; mean worm burden increased to 1,279 *E. multilocularis* tapeworms per one fox infected (Tab. 3).

During the whole study period, 709 of 2,226 foxes showed to be positive by SCT. Mean intensity of *E. multilocularis* infection was 1,076 worms with range from 1-40,000, and the total biomass in infected foxes was that of 762,837 specimens (Tab. 3).

Influence of climate and environmental factors to changes in prevalence and infection intensity. Simple correlation coefficients were calculated between prevalence and infection intensity of *E. multilocularis* in red foxes and variables of 3 environmental factors-mean annual air temperature, mean annual precipitations and relative density of small mammals.

Significant correlation was calculated between prevalence of the tapeworm in red foxes and mean annual precipitation (r = 0.933, p = 0.021) and between prevalence and population density of small mammals (r = 0.709, p = 0.022) (Tab. 4). Mean annual precipitation also significantly correlated with mean worm burden of *E. multilocularis* in red foxes (r = 0.973, p = 0.020). Non-significant correlation coefficients were calculated between other variables (Tab. 4).

The relation between prevalence of *E. multilocularis* in foxes and mean annual precipitation in individual years is shown on Figure 3. It is apparent that these parameters fluctuated synchronously and greatly declined in 2003 with a following increase in 2004.

Figure 4 shows the connection between prevalence of the parasite in red foxes and relative density of small mammals in individual surveyed seasons on the locality

Table 3. Mean worm burden of *Echinococcus multilocularis* in red foxes from the Slovak Republic.

	2000	2001	2002	2003	2004	2000-2004
Number of red foxes investigated by SCT	61	508	759	452	446	2,226
Number of red foxes infected	21	194	251	99	144	709
Number of isolated tapeworms	36,939	220,416	268,179	53,203	184,100	762,837
Mean worm burden	1,759	1,136	1,068	537	1,279	1,076
Min-max number of isolated tapeworms	1-15,000	1-25,000	1-40,000	1-10,500	1-16,000	1-40,000

SCT-sedimentation and counting technique

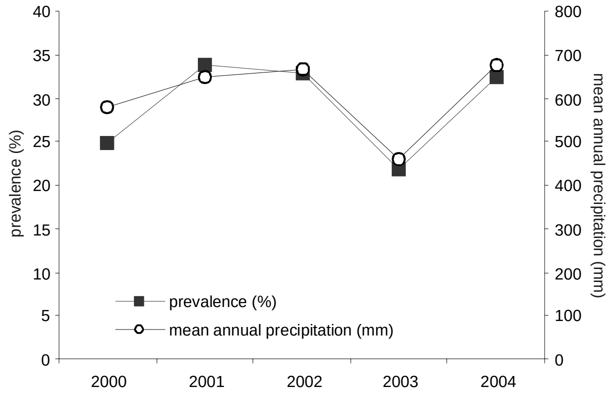

Figure 3. Relations between prevalence of *Echinococcus multilocularis* in red foxes and mean annual precipitation totals in individual years of monitoring.

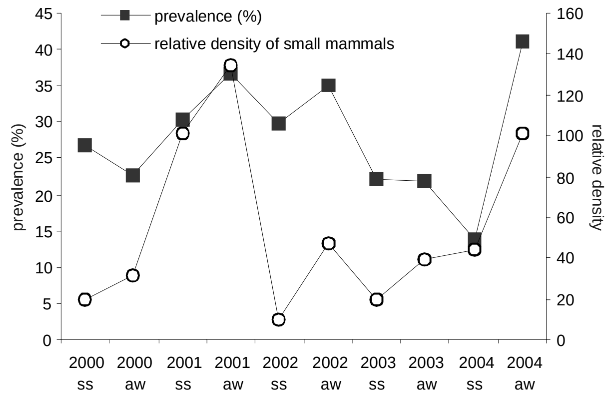

Figure 4. Relation between prevalence of *Echinococcus multilocularis* in red foxes and relative density of small mammals in individual surveyed seasons (ss-spring/summer; aw-autumn/winter).

Rozhanovce (southeastern Slovakia) where nearly 900 individuals of 12 mammal species were trapped. Murid rodens (family Muridae) absolutely dominated in the material (altogether, 79.4%) [32]. Again, a tight relationship between both parameters was recorded. Prevalence rate and small mammals' abundance reached peaks during the winter of 2001. In spring 2002, the relative density of small mammals rapidly decreased from 36.8-9.8 and remained at this bottom level until winter 2004 when a rapid increase of small mammals' population was noticed and relative density reached 101.2. Prevalence of *E. multilocularis* in foxes decreased gradually and in the first half of 2004 reached only 13.8 ± 4.3%. In the second half of 2004, more than 40.0% of foxes were infected.

DISCUSSION

The results of long-term monitoring of the *Echinococcus multilocularis* distribution in the Slovak Republic refer to the occurrence of 2 endemic areas with the tendency of gradual merger. One of them is situated in northwestern Slovakia, in Žilina region and continues to the mountainous territory of central Slovakia; the second endemic area was identified in northeastern Slovakia, in Prešov region. Prevalence rates in several districts of northern and central parts of the country fluctuated between 40% and more than 60% from the beginning of the survey. Also, the first 4 cases of autochthonous alveolar echinococcosis in the Slovak Republic were diagnosed from 2001 in patients living in districts of the northern and central parts of the country, distinguished by the highest prevalence and mean worm burden of *E. multilocularis* in foxes [7, 8, 9]. The differences between high prevalence rates in the north and low prevalence in the southwestern and southeastern Slovakia are evident, but not yet be clearly explained. Differences in population densities of foxes, intermediate hosts and environmental conditions may play an important role. The significant increase in red fox population is probably associated with the successful programme for their vaccination against rabies recorded after 1996 in the Slovak Republic. The value of the population density of red foxes fluctuates around 270 specimens per 1,000 km^2 and seem to be distributed regularly in the whole territory. On the other hand, the population density of small mammals-intermediate hosts of *E. multilocularis*, has been measured in only a few areas and no blanket monitoring of their population has been performed in Slovakia. Positive correlation between population density of red foxes and prevalence rate of *E. multilocularis* was observed, for example, in southern Germany [26], while in southeastern Germany this hypothesis was not acknowledged [34]. As the *E. multilocularis* tapeworm is considered a cold climate parasite and its eggs are very sensitive to desiccation and high temperatures [36], geological and climatic factors may be of key importance for their survival and for the spread of the infection. The present survey provides evidence that the highest prevalence and infection intensity were found in northern part of the country - mainly mountainous with mixed and coniferous forests, pastures and a high proportion of natural vegetation. Climatic conditions in the north differ significantly from those of other parts of the country. Northern districts are distinguished by low mean annual air temperature (4-8ºC), high mean annual precipitations (700-1,300 mm) and low mean annual soil surface temperature (3-7ºC). Soil in northern Slovakia is mainly loamy and is characterized by high humidity. The mean annual values of radiation index of drought moved from 0.47-1.28 in the north, while in the southern parts of the country it reaches higher rates and fluctuated between 1.0-1.54 [14]. Similar epidemiological studies carried out in endemic regions in France showed that the highest occurrence of the tapeworm in red foxes were recorded, and the human cases of alveolar echinococcosis were diagnosed mostly in mountainous areas with a high proportion of permanent grassland [6, 22]. Danson *et al.* [2] also determined a positive correlation between prevalence of alveolar echinococcosis and abundance of grasslands, as well as secondary forests in the landscape. Such climatic and geomorphologic conditions seem to be fitting for the suitable intermediate hosts' occurrence. In Slovakia, the most abundant species of *E. multilocularis* intermediate hosts is *Microtus arvalis,* which prefers forest margins, luminous and fragmented forests, and meadows and fields with a high proportion of shrubberies [24]. Fragmentation of forests also positively affects the abundance of red foxes [12, 13]. Additionally, Yokohata and Kamiya [38] discovered that the population density of voles, cumulative temperature and the number of days with snowfall deeper than 50 cm showed the highest correlation coefficients for the prevalence of the parasite in red foxes. On the other hand, the soil attributes also seem to be very important for the survival of the oncospheres of the tapeworm. For example, in the endemic areas of southern Germany, no infected foxes have been found in dry localities with sandy soil [34]. In our survey, the lowest infection rate of *E. multilocularis* in red foxes was recorded during the whole study period in agrarian districts of southern Slovakia (Bratislava, Trnava and Košice region), distinguished by warm and dry or very dry climate, high annual air temperature (8-12ºC), low annual rainfall (450-680 mm) and high temperature of soil surface (10-12ºC). The soil in southern parts of the country is dry or slightly moist, with a higher proportion of sand.

In our survey prevalence rates and infection intensity of *Echinococcus multilocularis* fluctuated during the studied years and fluctuation patterns were similar in all regions of Slovakia. From 2000-2002, the prevalence showed an increasing tendency with the highest values in northern districts of the country. In 2002, a new locality of the high *E. multilocularis* occurrence was identified in the southern part of Banská Bystrica and Nitra regions, in districts bordering Hungary. In 2002, the first finding of this cestode in Hungary was recorded. All 5 positive foxes were captured in localities close to the border of Central Slovakia [31]. Similar trends of growing prevalence were observed also in others countries with complex and long-term studies on *E. multilocularis* distribution. For example, in the Tübingen area in the state of Baden-Württtenberg, southwest Germany, in 1974-1984 the mean prevalence rate was 18.3% and in 1989 and 1990 reached 55.6% and 58.5%, respectively [29, 30]. A number of studies carried out in Germany documented that *E. multilocularis* was spreading to formerly non-endemic areas, with evidence of an increasing overall prevalence [25]. Prevalence values accounted grooving trends also in some regions of France [4, 5, 20] and Belgian province of Luxemburg [1, 15]. After the growing character of the *E. multilocularis* prevalence in 2000-2002, surprisingly, its significant decrease was recorded in 2003. In the endemic area of Žilina region its value came down from 68.6% in 2002 to 31.0% in 2003, and in Prešov region from 44.4% to 30.1%. During the first half of 2004, the decline of the tapeworm prevalence in red foxes continued and reached only 13.8 ± 4.3%. In the autumn/winter season of 2004, mean prevalence of *E. multilocularis* rapidly increased to 41.2 ± 18.1%, with its maximal value of 45.9% in Prešov region. Sudden fluctuation of prevalence within a few years was observed also by Kritsky and Leiby [11] in North Dakota, USA. In 1965, they recorded a prevalence of *E. multilocularis* in red foxes of 59.1%, in 1966, and 1967 noticed its decline to 21.7% and 7.7%, respectively, while in 1971, the prevalence increased again to 21.5%. Fluctuation of the prevalence of *E. multilocularis* could be attributed to the changes of climatic conditions that can consequently influence the population densities of the small mammals-main intermediate hosts of the parasite. Sudden climatic changes, which are no remarked in mean monthly values, seem to be very important for the reproduction and the survival of *E. multilocularis* intermediate hosts. Pucek *et al.* [21] studied rodent population dynamics in northeastern Poland during a 33-year period. Population densities in 2 rodent species (*A. flavicollis* and *C. glareolus*) were influenced by several factors, seed crops, temperature in June-July, duration of snow cover, etc. Another author, Májsky [16], in his paper presents events from March 1977, when a great decrease in nightly temperature was recorded and a following decline of small mammals' abundance in subsequent months was observed. In our study, 2003 was characterized by an important oscillation from the average *E. multilocularis* infection rate in Slovakia. The reason for the great fluctuation of prevalence and infection intensity in the present survey during half a year could be sudden climatic changes; for example, drought and lack of rainfall could be the likely cause of faster desiccation of the tapeworms' eggs. Dramatic climatic changes connected with devastation of natural small mammals' habitat, and a particularly sharp decrease of the nightly air temperature during spring could be a reasons for the rapid decline in their abundance. According the data of the Slovak Hydrometeorological Institute, the year 2003 was distinguished by very specific climatic conditions. It was the sixth warmest since 1871, and the summer of 2003 the warmest in the history of meteorological observations in Slovakia; the character of the climate was enormously dry, with a lack of rainfall, and precipitation values were the lowest since the beginning of the 20th century. Mean annual air temperatures in 2003 was higher, from 2.1ºC to 4.0ºC, compared with last 30 years [28]. Besides climatic changes, other ecological factors should also be considered a reason for the observed differences between-year infection rates. Population density of *E. multilocularis* intermediate hosts seems to be the most important factor. Saitoh and Takahashi [27] discovered that infection rates in red foxes depended on the current-year abundance of voles in 3 studied areas; in addition to this, direct density-dependence, delayed density-dependence between the infection rate and the prior-year abundance of voles was detected in 2 studied areas in Japan. In our study, we also noticed the tight relationship between prevalence of *E. multilocularis* in red foxes and relative density of small mammals in individual surveyed seasons. After the decline of small mammals' abundance in 2002, a delayed decrease of infection rate in foxes was observed, with a follow increase in both parameters in the second half of 2004. Calculation of simple correlation coefficient showed that 2 of the weighted ecological factors-mean annual precipitations and relative density of small mammals-are important for the *E. multilocularis* infection rate in the Slovak Republic.

CONCLUSION

In conclusion, the present study shows the existence of a high-endemic focus for *Echinococcus multilocularis* in the northern part of the Slovak Republic, and demonstrates that localities with low mean annual temperature, high annual precipitation values and moisture soil could be recorded as the areas with the highest risk for infection of alveolar echinococcosis in humans. In fact, the first 4 cases of autochthonous alveolar echinococcosis have been diagnosed to date in people living in the endemic regions. The highest prevalence of tapeworms in red foxes is permanently found in Žilina region in northwestern part of the country. Risk infection in this area is growing with the fact that 51.2% of its territory is declared as protected natural reservations serving as holiday resorts. Next, our epizootological survey shows the tight relationships and positive correlation coefficient between rainfall amounts, small mammals' density and *E. multilocularis* infection in red foxes. The present analyses were simplistic and many other factors were not weighted; therefore, additional monitoring is required and more analyses must be made available to explain both the spatial and temporal patterns of the *E. multilocularis* distribution in the Slovak Republic. Because of the close relationship between infection rate in red foxes and small mammals' population density, a long-term survey of individual small-mammals species in more regions of Slovakia would be necessary.

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