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Factors Influencing the Circulation of Toxocara in Different Ecosystems in Slovakia

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Introduction

The prevalence of a serious helminthic zoonosis – human larval toxocarosis – differs with individual countries (28). These differences are caused by the climatic conditions, domestic carnivore breeding methods, environmental hygiene, use of leisure time and dietetic habits of people etc. (2, 15).

Slovakia is among the countries with a high incidence of human larval toxocarosis (17), with seroprevalence in healthy population as high as 13.65% (10). This unfavourable situation is influenced by the climatic conditions suitable for the development and survival of *Toxocara* eggs. Domestic carnivores kept in flats of rent houses deposit their faeces over the small areas of the adjacent public grounds. Stray dogs and cats with unchecked health status frequently appear in towns.

The countryside often lacks free ranges reserved for dogs and separated from gardens. Gardens and other public grounds in towns and villages are freely accessible to cats. Numbers of town people spend their leisure time in gardens on the outskirts of towns frequented not only by domestic but also free-living carnivores, above all foxes, which are major disseminators of *T. canis* eggs (20). *Toxocara* eggs are found in the soil and sand samples taken from children playgrounds (3, 12, 13, 28). Because of their uneven dissemination and different time of survival, the finding of eggs does not always exactly reflect the degree of environmental contamination with infective eggs.

In the central parts of towns, in suburban areas and in the countryside, small mammals, which are paratenic hosts of *Toxocara* appear in high numbers. Their permanent contact with soil brings about frequent infections with toxocaral larvae cumulating in their organism. Small mammals may also transfer the larvae to their progeny either intrauterine or by lactation (24). Thus the population of small mammals is permanently infected with *Toxocara* larvae and may play an important role in the circulation of toxocarosis (7).

This paper discusses some factors influencing the incidence of human larval toxocarosis in the macroregions and its circulation in the microregions of the Slovak Republic.

Slovakia is administratively divided into three geographic macroregions: western, central and eastern. The western region is largely lowland with vast fields of agricultural soil. Its northern part extends into hills. The central region is hilly, wooded, only its southern part is predominated by arable land. The northern part of the eastern region is hilly, but its southern part is formed of intensive lowlands with sandy agricultural soil.

With respect to the variety of factors influencing human toxocarosis in the microregions, our study was conducted in two geographically neighbouring localities, an urban and a rural locality. Along with both the localities also their adjacent sublocalities were studied.

Materials and methods

Research was carried out at 2 localities and 3 sublocalities with different degrees of human involvement and with following characteristics:

- Urban locality: central part of Košice city.
- Urban sublocalities: suburban, peripheral part of Košice city and Park forest, recreational area.
- Rural locality: countryside settlements.
- Rural sublocality: village with a population of 3,600 in the southern part of the rural locality.

Sera of suspected patients were obtained for examination from the medical institutions in the different regions of Slovakia. Sera of clinically healthy adults were obtained from blood banks. Finally, sera of clinically healthy children, aged 2 - 15, were collected for a targeted epidemiological survey.

The carcasses of domestic carnivores, euthanized at their owners' request or killed in car accidents, were supplied by the veterinary diagnostic service. The age of dogs and cats under 12 months was determined by the degree of exfoliation and in older animals by Eidman's method (9).

Free-living small mammals were trapped from March through November, identified zoologically and subjected to necropsy. The heart with its blood clot was cut open, eluted in 1 ml of saline and centrifuged at 500 g for 2 min (25). The eluate was used for serological examination. Relative density was expressed as the number of small mammals in 100 traps.

Anti-*Toxocara* antibodies were determined in human serum and in the eluate from the heart of small mammals using an ELISA (7) with *T. canis* excretory-secretory larval antigen prepared by the method of DE SAVIGNY (5).

The carcasses of domestic carnivores were examined by the helminthological dissection. The carnivore faeces were examinehern part of the eastern region is hilly, but its southern part is formed of intensive lowlands with sandy agricultural soil.

Results

Table 1 shows the results obtained by the examination of dogs and cats for the presence of *Toxocara* eggs in the faeces and the seropositivity for larval toxocarosis in suspected patients from the regions of Slovakia. The eastern region with the highest count of *T. canis* eggs in the faeces of dogs (18.0%) and of *T. cati* in cats (31.9%) had also the highest incidence of human toxocarosis (16.1 cases per 10^5 population), markedly above the nation-wide average (9.2 cases).

Seroligic evaluation of the collected sera (Fig. 1) showed a seroprevalence of approximately 50% in children under 15 years and in adults, however, there were fewer positive male than female patients (43.9 and 56.1%, respectively).

Table 2 presents the results obtained by dissection of dogs. In urban dogs of three age categories (the groups of 2 and 3 years old were not evaluated because of their small numbers), the highest prevalence (75.0%) and mean intensity of *T. canis* (9.9 specimens) were

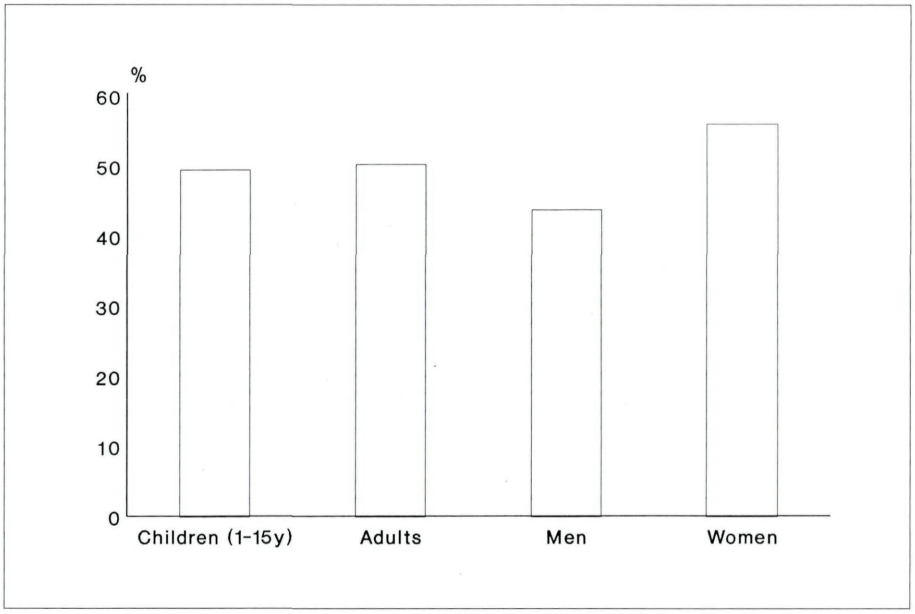

Figure 1:

Seroprevalence of larval toxocarosis in suspected patients in Slovakia in 1990 - 1993 by age and sex.

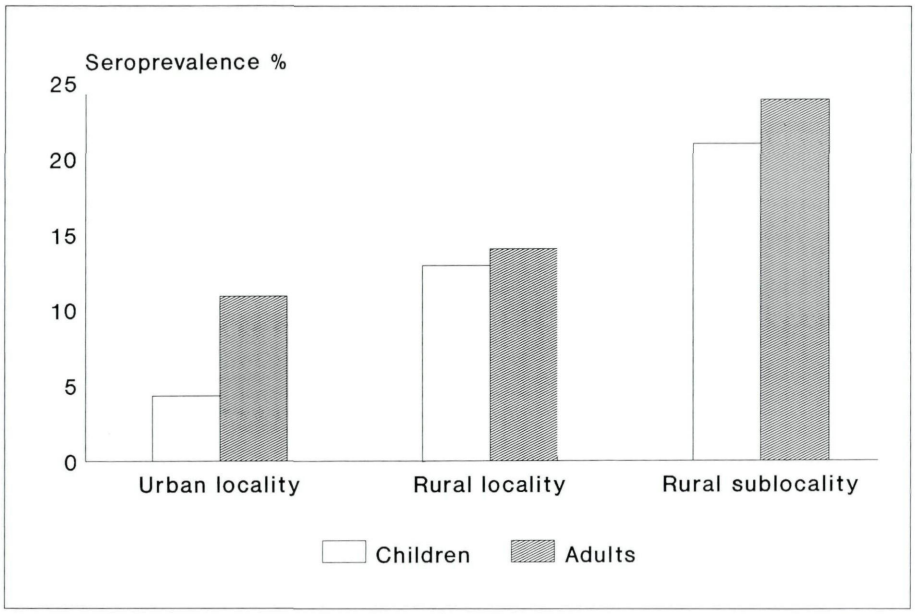

Figure 2:

Seroprevalence of larval toxocarosis in clinically healthy children and adult persons in 1991 - 1992.

detected in 1 - 6 months old pups. With increasing age of the dogs toxocarosis occurred less frequently. The numbers of helmith species found in urban dogs was surprisingly low, only *T. canis* and *Dipylidium caninum* were detected. A considerably higher number of species was found in dogs from the rural locality, hosting 3 nematode and 4 cestode species.

Table 3 illustrates the results of cat dissection. The prevalence of *T. cati* is high, exceeding 50% in all age categories, with the maximum mean intensity in cats aged 3 years and more (19.5 specimens). Interestingly, this finding shows that urban cats have a more varied helminth fauna than cats from the rural locality, thus suggesting the predominance of straying cats.

The environmental contamination of the studied urban locality with *Toxocara* spp. eggs (Tab. 4) is high. Important is the finding of eggs (22.6% positive samples) in the fenced areas of kindergartens, which are inaccessible to dogs but may be contaminated by cat faeces. The public grounds in the rural locality were not contaminated with *Toxocara* eggs.

The species representation and occurrence of small mammals varied to a great extent in the localities studied (Tab. 5). The species representation (4 species: *Sorex araneus, Crocidura suaveolens, Apodemus agrarius, Clethrionomys glareolus*) and relative density (4.5 specimens) of small mammals in the urban locality were much lower than those in the rural locality (9 species: *Sorex araneus, S. minutus, Neomys anomalus, Crocidura suaveolens, Mus musculus, Micromys minutus, Apodemus agrarius, A. microps, Microtus arvalis;* relative density: 14.1 specimens). The occurrence of anti-*Toxocara* antibodies in the serum of small mammals from both the urban and the rural localities was almost identical (22.2 and 21.6%, respectively). This proves the heavy environmental contamination with *Toxocara* eggs. In the sublocalities visited by town people (Suburban and Park forest), the relative density of small mammals is high, although their seropositivity is lower, only 12.8 and 12.0%.

Regions	Toxocara spp. eggs in faeces						Morbidity rate per 10^5 population
	Dogs			Cats			
	N	n	pos. %	N	n	pos. %	
Western	2372	195	8.2	272	11	4.0	7.9
Central	1781	162	9.1	85	10	11.8	4.5
Eastern	1708	307	18.0	91	29	31.9	16.1
Slovakia	5861	664	11.3	448	50	11.2	9.2

Table 1:

Relation between toxocarosis of dogs and cats and the morbidity rate in humans with larval toxocarosis in the regions of the Slovak Republic in 1990 - 1993.
(N = number examined · n = number positive)

Table 2: Prevalence (P %) and mean intensity of specimens (I spec.) of helminths in dogs from urban and rural localities.

	Locality:	Urban					Rural				
	Age:	1-6 m	7-12 m	2 Y	3 Y	4 Y and more	1-6 m	7-12 m	2 Y	3 Y	4 Y and more
	n:	12	11	0	0	15	16	32	18	15	13
Toxocara canis	P %	75.0	54.0	–	–	27.3	43.7	46.9	27.8	26.7	0.0
	I spec.	9.9	6.4	–	–	3.7	3.8	5.7	7.8	2.5	–
Toxascaris leonina	P %	0.0	0.0	–	–	0.0	0.0	0.0	5.6	0.0	0.0
	I spec.	–	–	–	–	–	–	–	1.0	–	–
Uncinaria stenocephala	P %	0.0	0.0	–	–	0.0	0.0	0.0	6.2	0.0	0.0
	I spec.	–	–	–	–	–	–	–	5.0	–	–
Mesocestoides lineatus	P %	0.0	0.0	–	–	0.0	0.0	3.1	0.0	0.0	0.0
	I spec.	–	–	–	–	–	–	6.0	–	–	–
Dipylidium caninum	P %	58.3	9.1	–	–	0.0	25.0	9.4	22.2	20.0	0.0
	I spec.	6.4	3.0	–	–	–	10.5	8.3	1.3	9.3	–
Taenia pisiformis	P %	0.0	0.0	–	–	0.0	0.0	3.1	0.0	6.7	0.0
	I spec.	–	–	–	–	–	–	3.0	–	8.0	–
Taenia hydatigena	P %	0.0	0.0	–	–	0.0	0.0	3.1	16.7	0.0	7.7
	I spec.	–	–	–	–	–	–	3.0	4.0	–	2.0

Table 3: Prevalence (P %) and mean intensity of specimens (I spec.) of helminths in cats from urban and rural localities.
(* = Finding of nodules, eggs and L_1 larvae in the lungs)

	Locality:	Urban				Rural			
	Age:	1-6 m	7-12 m	2 Y	3 Y and more	1-6 m	7-12 m	2 Y	3 Y and more
	n:	24	19	17	12	0	9	9	4
Toxocara cati	P %	79.2	57.9	58.8	83.3	–	55.5	88.9	50.0
	I spec.	8.2	6.2	10.4	19.5	–	6.8	4.9	3.0
Uncinaria stenocephala	P %	0.0	0.0	0.0	0.0	–	11.1	0.0	0.0
	I spec.	–	–	–	–	–	1.1	–	–
Aelurostrongylus abstrusus	P %	0.0	0.0	0.0	8.3	–	0.0	0.0	0.0
	I spec.	–	–	–	*	–	0.0	0.0	0.0
Mesocestoides lineatus	P %	4.2	0.0	0.0	0.0	–	0.0	0.0	0.0
	I spec.	6.0	–	–	–	–	–	–	–
Dipylidium caninum	P %	8.3	21.0	5.9	8.3	–	0.0	0.0	0.0
	I spec.	1.5	1.3	2.0	7.0	–	–	–	–
Taenia taeniaeformis	P %	0.0	0.0	5.9	16.7	–	11.1	11.1	25.0
	I spec.	–	–	4.0	1.5	–	2.0	1.0	2.0

Sampling sites (Substrate examined)	Urban locality			Rural locality		
	No. samples N	n	Positivity %	No. samples N	n	Positivity %
Separate sand pits (Sand)	47	17	36.2	16	0	0
Public grounds (Soil)	22	4	18.2	16	0	0
Kindergarten areas (Sand, soil)	31	7	22.6	39	0	0

Table 4:

Finding of Toxocara spp. eggs in urban and rural ecosystems.
(N = number examined samples · n = number positive samples)

Small mammals (details see p. 53)	Urban locality	Urban sublocalities		Rural locality	Rural sub-locality
		Suburban	Park forest		
Total number of species	4.0	8.0	10.0	9.0	9.0
Relative density/100 traps	4.5	9.3	12.7	14.1	16.2
Number of specimen	18.0	117.0	200.0	148.0	66.0
Number of seropositive	4.0	15.0	24.0	32.0	14.0
Seropositivity %	22.2	12.8	12.0	21.6	21.2

Table 5:

Investigation of small mammals trapped in the studied localities and the occurrence of anti-Toxocara antibodies in their serum.

Our attention has been focused on the research of a rural sublocality with the population of 3,600 with frequent clinical toxocarosis in children. This sublocality showed a high concentration of dogs, 1 dog per 13 people. In the urban locality it was 1 dog per 23 people. As much as 20.8% of collected faecal samples of dogs were positive for *T. canis* eggs, which is almost twice as much as the average for Slovakia – 11.3% (Tab. 1). The sublocality (Tab. 5) has a high relative density of small mammals (16.2 spec.) which are highly seropositive (21.2%). These factors obviously cause the high seroprevalence in healthy children and healthy adult population of this rural sublocality, 20.9 and 23.8%, respectively (Fig. 2). This seroprevalence is much higher than that recorded in the rural and urban localities.

Discussion

People living in the environment contaminated with the disseminated infective *Toxocara* eggs are exposed to a great hazard of infection. A direct correlation has therefore been found between the number of carnivores and the human morbidity rate. The number of individuals contracting the disease may also be either negatively or positively determined by other factors. There has been no evidence of *Toxocara* larval infection in Slovakia due to undercooked meat. However, with respect to the incidence of human trichinellosis (6), this way of infection cannot be precluded. We are more inclined to believe that people may become orally infected with infective eggs.

This way of infection is determined by two highly hazardous factors. Firstly, the high concentration of people in the small areas of town housing estates. The most threatened here are children playing in sand pits and on public grounds. The eggs, however, are carried on shoes and with dust into flats, thus even increasing the risk of human infection. Secondly, it is the way dogs are kept in the countryside and the suburban areas, where they have free access to vegetable gardens (16). It is the contact with soil that is considered a major reason for the higher morbidity in women than in men (26). The high concentration of eggs on the free ranges for dogs is particularly observed in the places where pups with the high preva-

lence of *T. canis* are kept (2). Rural dogs may also become infected by feeding on small mammals, which is also evident from the finding of *Mesocestoides lineatus* and from the finding of *T. canis* in dogs of higher age categories (29).

Small mammals are likely to play a major role in cat infection (2)). This fact has been indicated by the high prevalence of *T. cati* in cats of all age categories as well as by the finding of *M. lineatus* and *T. taeniaeformis*. Cats may play a more important role in the spread of toxocarosis than it has been admitted, particularly as regards the incidence of ocular larva migrans (18). The unrestricted and uncontrolled movement of cats (21) and existence of large urban populations of stray cats (19) allow for the dissemination of eggs over extensive areas inside and near the towns and villages.

As suggested by the data (20), the role of foxes in the dissemination of *T. canis* eggs in the urban and suburban localities is also underestimated. Rabies is maintained in the environment largely by foxes (23), and its frequent occurrence in the urban locality studied support our presumption.

The recent findings of the high anti-*Toxocara* antibody level in the serum of small mammals show their frequent contact with *Toxocara* eggs. Larvae may be cumulated in the organism of small mammals (8). In view of the mode of small mammals' life they can be considered the bioindicators of the egg disseminations. While rodents living underground become infected with disseminated eggs, some species of insectivores feed also on excrements (1). The presence of anti-*Toxocara* antibodies in the serum of small mammals is a reliable indicator of infection. Some studies have shown that antibodies are detectable even after infection with as few as 5 *Toxocara* eggs (11, 14).

The discussion suggests that *Toxocara* spp. infection in carnivores, the degree of contamination of man's environment with eggs and larval infection in small mammals are the main factors of toxocarosis circulation in different ecosystems.

Summary The paper refers to the factors influencing the prevalence of toxocarosis. The human morbidity rate for larval toxocarosis in the regions of Slovakia correlated with the findings of *Toxocara* eggs in dog and cat faeces. Among domestic carnivores disseminating *Toxocara* eggs in the environment dogs under 1 year of age had the highest prevalence of *T. canis*. The highest prevalence of *T. cati* in cats of all age categories was above 50% and the highest mean intensity (19.5 spec.) was detected in cats aged 3 and more years. Small mammals are bioindicators of environmental contamination with *Toxocara* infective eggs and play a major role in the circulation of this nematode in urban and rural ecosystems. In this respect, toxocarosis may be classified as an anthropopurgic focal zoonosis. The cumulation of factors favouring *Toxocara* circulation (the way of dog keeping, cumulation of their faeces in a small space, high relative density of small mammals, favourable climatic conditions etc.) may be responsible for an increase of childrens' morbidity due to larval toxocarosis in these ecosystems.

Key words *T. canis, T. cati* (syn. *T. mystax*), human toxocarosis, circulation, ecosystem.

Zusammenfassung *Bestimmende Faktoren der Prävalenz von Toxocara in der Slowakei*

Die Prävalenz der Toxokarose des Menschen in der Slowakei ist direkt korreliert mit dem Vorkommen und der Häufigkeit von *Toxocara*-Eiern in Hunde- und Katzenfäkalien. Junge Hunde (Alter: < 1 Jahr) sind die wichtigsten Ausscheider von *Toxocara canis*-Eiern, der Befall der Katzen mit *T. cati* liegt in allen Altersgruppen über 50%, wobei 3jährige und ältere Katzen eine durchschnittliche Befallsintensität von 19,5 Würmern aufweisen.

Kleinsäuger stellen einen wichtigen Bioindikator für die Kontamination der Umwelt mit *Toxocara*-Eiern dar; sie spielen darüber hinaus eine wichtige Rolle in der Zirkulation der Toxokarose in urbanen und ländlichen Ökosystemen. Unter diesem Aspekt kann die Toxokarose als „fokale anthropopurginäre Zoonose" bezeichnet werden.

Als Faktoren, die die Zirkulation der Toxokarose günstig beeinflussen, gelten: freie Art der Hunde- und Katzenhaltung, Anhäufung von Haustieren auf kleinen Flächen, hohe relative Dichte von Kleinsäugern, günstige klimatische Verhältnisse (hohe Temperatur, hohe Luftfeuchtigkeit). Eine Kumulation dieser Faktoren könnte für die Zunahme der Morbiditätsrate der Toxokarose bei Kindern verantwortlich sein.

Schlüsselwörter *Toxocara canis, T. cati* (syn. *T. mystax*), Toxokarose des Menschen, Zirkulation, Ökosystem.

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References

1. ANDĚRA, M., HORÁČEK, K. (1982):
Identification of Mammals.
Mladá fronta, Praha.

2. BARRIGA, O. O. (1988):
A critical look at the importance, prevalence and control of toxocariasis and the possibilities of immunological control.
Vet. Parasitol. 29, 195-234.

3. BOREHAM, P. F. C., CAPON, A. G. (1982):
Environmental contamination with canine zoonotic helminths in Brisbane.
Austrial. Vet. Practioner 12, 14-18.

4. BREZA, M. (1959):
Improvement in the technique of coproovoscopic examination of faeces of pigs by employment of a new flotation solution and liquid mucogel.
Veter. Čas. 8, 569-577.

5. DE SAVIGNY, D. H. (1975):
In vitro maintenance of Toxocara canis larvae and a simple method for the production of Toxocara ES antigen for use in serodiagnostic tests for visceral larva migrans.
J. Parasitol. 61, 781-782.

6. DUBINSKÝ, P., ŠTEFANČÍKOVÁ, A., HOVORKA, I., MITTERPAK, J. (1994):
Epidemiology of trichinellosis in Slovakia.
In: Campbell, W. C., Pozio, E., Bruschi, F. (Eds.): Trichinellosis, 515-517.
Istituto Superiore di Sanita Press, Rome.

7. DUBINSKÝ, P., HAVASIOVÁ-REITEROVÁ, K., PEŤKO, B., HOVORKA, I., TOMAŠOVIČOVÁ, O. (1995):
Role of small mammals in the epidemiology of toxocarosis.
Parasitology, 110, 187-193.

8. DUNSMORE, J. D., THOMPSON, R. C., BATES, I. (1983):
The accumulation of Toxocara canis larvae in the brains of mice.
Inter. J. Parasitol. 13, 517-521.

9. FORST, P. (1984):
Game Management.
Príroda, Bratislava.

10. HAVASIOVÁ-REITEROVÁ, K., DUBINSKÝ, P., ŠTEFANČÍKOVÁ, A. (1993):
A seroepidemiological study of Toxocara infection in humans in the Slovak Republic.
J. Helminthol. 67, 260-267.

11. HAVASIOVÁ-REITEROVÁ, K., TOMAŠOVIČOVÁ, O., DUBINSKÝ, P. (1995):
Effect of various doses of infective Toxocara canis and Toxocara cati eggs on the humoral response and distribution of larvae in mice.
Parasitol. Res. 81, 13–17.

12. HOLLAND, C., O CONNOR, P., TAYLOR, M. R. H., HUGHES, G., GIRDWOOD, R. A., SMITH, H. (1991):
Families, parks, gardens and toxocariasis.
Scand. J. Infect. Diseases 23, 225–231.

13. JURIŠ, P., PLACHÝ, P., DUBINSKÝ, P. (1992):
Sanitary problems of dog breeding in the urban biotope focused to Toxocara spp.
Proceed. Scient. Confer. with Internat. Participation – Ecology and Veterinary Medicine, Košice, 109–111.

14. KAYES, S. G., OMHOLT, P. E., GRIEVE, R. B. (1985):
Immune responses of CBA/J mice to graded infections with Toxocara canis.
Infect. Immun. 48, 697–703.

15. LEE, K. T., MIN, H. K., CHUNG, P. R., CHANG, J. K. (1976):
Studies on the possible association of human visceral larva migrans with the habit of eating raw liver of domestic animals.
Korean J. Parasitol. 14, 51–60.

16. MAGNAVAL, J. F., BAIXENCH, M. T. (1993):
Toxocariasis in the Midi-Pyrénées region.
In: Lewis, J. W., Maizels, R. M. (Eds.): Toxocara and toxocariasis, 63–69.
Institute of Biology and the British Society for Parasitology, London.

17. MIKULECKÝ, M., Jr., DUBINSKÝ, P., ONDREJKA, P., ŠTEFANČÍKOVÁ, A. (1992):
Some aspects of the epidemiology and prognosis of zoonotic toxocarosis.
Helminthologia 29, 83–86.

18. PETITHORY, J. C., CHAUMEIL, C., LIOTET, S., ROUSSEAU, M., BISOGNANI, A. C. (1993):
Immunological studies on ocular larva migrans.
In: Lewis, J. W., Maizels, R. M. (Eds.): Toxocara and toxocariasis, 81–89.
Institute of Biology and the British Society for Parasitology, London.

19. PEŤKO, B. (1993):
Domestic cats as a source of human infestations of fleas in towns.
Českoslov. Epidem. Mikrobiol. Imunol. 42, 190–191.

20. RICHARDS, D. T., LEWIS, J. W. (1993):
Epidemiology of Toxocara canis in the fox.
In: Lewis, J. W., Maizels, R. M. (Eds.): Toxocara and toxocariasis, 25–37.
Institute of Biology and the British Society for Parasitology, London.

21. RÖDL, P. (1992):
Medical importance of stray cats in the human environment.
Českoslov. Epidemiol. Mikrobiol. Imunol. 41, 169–173.

22. ROMANENKO, N. A. (1968):
Methods of the examination of soil and sediment of wastewater on helminth eggs.
Med. Parazit. parazit. Bolezni 6, 723–729.

23. ŠVRČEK, Š., VRTIAK, O. J., MATOUCH, O., ALEXANDER, R., ONDREJKA, R. (1982):
Die Bedeutung des Rotfuchses in der Epizootologie der Tollwut in Europa.
Beitr. Jagd. Wildforsch. 12, 21–22.

24. TOMAŠOVIČOVÁ, O., HAVASIOVÁ-REITEROVÁ, K., DUBINSKÝ, P., HOVORKA, I. (1993):
Intrauterine and lactogenic transfer of Toxocara canis larvae in paratenic hosts.
Helminthologia 30, 111–113.

25. TREML, F., NESŇALOVÁ, E. (1993):
Serological screening of the occurrence of antibodies to leptospires in free-living small mammals.
Veter. Med., Praha 38, 559–568.

26. UHLÍKOVÁ, M., HÜBNER, J. (1983):
Larval toxocarosis.
Avicennum, Prague.

27. VOKOUN, P., SLEZÁKOVÁ, I. (1977):
Gastrointestinal parasites of urban dogs and cats.
Veter. Med., Praha 22, 367–376.

28. WALDER, M., ASPÖCK, H. (1988):
Untersuchungen über Häufigkeit und Bedeutung von Toxocara-Infektionen des Menschen in Österreich.
Mitt. Österr. Ges. Tropenmed. Parasitol. 10, 159–174.

29. WARREN, E. G. (1969):
Infections of Toxocara canis in dogs fed infected mouse tissues.
Parasitology 59, 837–841.

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