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TOXOPLASMA GONDII IN ZOO ANIMALS

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Summary

There are many reports on toxoplasmosis in zoo animals. In the Czech Republic, fatal toxoplasmosis was recorded in Saiga and Nilgais antelope and also in manuls. Several groups of zoo animals were tested for *T. gondii* antibodies during years 1995 and 2005 by indirect fluorescence antibody test (IFAT). However there are some other animal groups that have not been tested yet or method of IFAT was not suitable. Sera of 747 animals, including 59 birds and 688 mammals, from eight Czech and Slovakian zoos were tested for antibodies to *Toxoplasma gondii* by latex agglutination test. *T. gondii* antibodies were detected in 33.5 % (250/747) of the animals, concretely in 8.5 % (5/59) of the birds and 35.6 % (245/688) of the mammals. In case of birds, *T. gondii* antibodies were detected in birds belonging to the anseriformes, falconiformes and psitaciformes. In case of mammals, *T. gondii* antibodies were found in animals from the following orders: 59.3 % (54/91) carnivores, 35.3 % (6/17) proboscidea, 34.7 % (34/98) perissodactyla, 33.6 % (143/426) artiodactyla, 10.5 % (2/19) primates, 7.7 % (2/26) rodentia and in two animals of marsupialia and two of tubulidentata. *T. gondii* antibodies were not detected in insectivora, chiroptera and xenarthra. There were also differences in individual families: 63.5 % in felidae, 62.5 % in canidae and 14.3 % in other carnivores, 55.6 % in elephantidae and 12.5 % in other proboscidae, 37.5 % in equidae and 22.2 % in rhinocerotidae, 61.1 % in cervidae, 50 % in camelidae, 30 % in giraffidae, 29.1 % in bovidae and 12.5 % in suidae.

Introduction

Toxoplasma gondii is one of the most well studied parasites because of its medical and veterinary importance. *T. gondii* is a coccidian parasite with cats and other felids as the definitive host, and warm-blooded animals as intermediate hosts. Only cats and other felids may shed oocyst, which are essential in the life cycle of *T. gondii*. Natural infection is acquired by ingestion of oocyst from food and water contaminated with cat faeces or by ingestion of tissue cysts in meat of infected animals. *T. gondii* infection is usually asymptomatic, but it can lead to severe clinical manifestation in sensitive animals (DUBEY, 2010).

There are many reports on toxoplasmosis in zoo and captive animals. Clinical cases of toxoplasmosis (encephalomyelitis) were recorded for example in a captive fossa (*Cryptoprocta ferox*) from a Spanish zoo (CORPA et al., 2013), in Tammar wallabies (*Macropus eugenii*) in the Budapest Zoo and Botanical Garden (SÓS et al., 2012), or in Eastern grey kangaroos (*Macropus giganteus*) in Mexico (CRUZ-HERNANDEZ et al., 2012). In the Czech Republic, the clinical manifestation of *T. gondii* infection was found in zoo keept Nilgais (*Boselaphus tragocamelus*) and Saiga antelopes (*Saiga tatarica*) (SEDLÁK et al., 2004). LUKEŠOVÁ AND LITERÁK (1997) monitored shedding of *T. gondii* oocysts in the faeces of felidae in six zoos in the Czech Republic.

It is important to know prevalence of *T. gondii* in different groups of zoo animals to know which of them are more or less sensitive to *T. gondii* infection, and thus to know if there is lower or higher risk of possible infection from mother to offspring during transplacental infection. There can be problems with aborts, mild or more complicated clinical symptoms that could be even fatal for the animals. In case of felids positive to *T. gondii* infection, there is a risk of shedding *T. gondii* oocysts and contamination of zoo environment. There are differences in susceptibility to *T. gondii* infection among species. Antibodies to *T. gondii* were found for example in 63.4 % (102 of 161) wild felids and in 50.5 % (49 of 97) wild canids from the zoos in Brazil (ANDRE et al., 2010), and in 53.3 % (89 of 167) exotic mammals from zoos in Mexico (ALVARADO-ESQUIVEL et al., 2013). There is also one study from the Czech Republic (SEDLÁK and BÁRTOVÁ, 2006). Sera of zoo animals (556 animals of 114 species) were collected during years 1995 – 2005 and *T. gondii* antibodies were detected by indirect immunofluorescence (IFAT) in 193 (34.7 %) animals. The highest prevalence 100 % was found in families: Hyaenidae, Mustelidae, Ursidae and Viveridae of the order Carnivora.
The aim of this study was to determine the prevalence of antibodies to *T. gondii* in groups of zoo animals from the Czech and Slovakian zoos that were not included in previous study.

Material and methods

Sera of 747 clinically healthy animals (59 birds and 688 mammals) were collected in eight Czech and Slovakian zoos. The sera were centrifuged and frozen at -20°C until they were examined. The serum samples were tested for antibodies against *T. gondii* by latex agglutination test (LAT, Pastorex toxo, Bio-Rad Laboratories s .r.o., CR). According to the instructions, the specifity and sensitivity of LAT is 100 % and 94.3 %, however species-related difference could have been observed due to species-specific differences in sensitivity and specificity.

Results and discussion

Antibodies against *T. gondii* were detected in 33.5 % (250 of 747) of all tested animals. In case of birds, it was 8.5 % (5/59) with 20 % prevalence in psitaciformes. *T. gondii* antibodies were detected also in anseriformes (2/4) and falconiformes (2/4); other tested birds of eight orders were negative for *T. gondii* antibodies (table 1).

Tab.1: Prevalence of T. gondii antibodies in birds from zoo.

Order/family	Positive/n (%)	*T. gondii* positive species
Anseriformes	2/4 (50 %)	Paradise shelduck (*Tadorna variegata*), coscoroba swan (*Coscoroba coscoroba*)
Falconiformes	2/4 (50 %)	Steppe eagle (*Aquila nipalensis*), bald eagle (*Haliaeetus leucocephalus*)
Psittaciformes	1/5 (20 %)	Rainbow lorikeet (*Trichoglossus haematodus*)
Birds of other 8 orders	0/46 (0 %)	
Total	**5/59 (8.5 %)**	

Seroprevalence of *T. gondii* among all mammal species was 35.6 % (245 of 688). *T. gondii* antibodies were detected in mammals from the following orders: Carnivora in 59.3 % (54/91), Proboscidea in

55.6 % (5/9), Artiodactyla in 33.6 % (143/426), Perissodactyla in 34.7 % (34/98), Hyracoidea in 12.5 % (1/8), Primates in 10.5 % (2/19), Rodentia in 7.7 % (2/26) and in two animals of Tubelidentata and two of Diprotodontia. *T. gondii* antibodies were not detected in Eulipotyphla, Chiroptera and Xenarthra. There were differences in individual families. Antibodies to *T. gondii* were found in 63.5 % in felidae, 62.5 % in canidae and 14.3 % in other carnivores, 55.6 % in elephantidae and 12.5 % in other proboscidae, 37.5 % in equidae and 22.2% in rhinocerotidae, 61.1 % in cervidae, 50 % in camelidae, 30 % in giraffidae, 29.1 % in bovidae and 12.5 % in suidae. The results are summarised in table 2.
Differences in the seroprevalence of *T. gondii* among species or higher zoological taxons could be explained by different sensitivity, different lifestyles (carnivorous, herbivorous) and by possibility to be in contact with the sources of *T. gondii* infection. We found the highest prevalence (59.3 %) in Carnivora since their representatives (Felidae) could be definitive host of *T. gondii* infection. The most common way of infection for carnivors is consumption of meat contaminated with *T. gondii* tissue cysts. Relative high prevalence was found in animals of orders Proboscidea (55.6 %), Artiodactyla (33.6 %) and Perissodactyla (34.7 %), Herbivores could be infected especially by drinking water and feeding grass contaminated with *T. gondii* oocysts. In some groups of animals, transplacental transmission of *T. gondii* infection is also very important.

Tab. 2: Prevalence of T. gondii antibodies in mammals from zoo.

Order	**Family**	**Positive/total (%)**	***T. gondii* positive species**
Carnivora	Felidae	33/52 (63.5 %)	Tiger (*Panthera tigris*), lion (*P. leo*), leopard (*P. pardus*), ocelot (*Leopardus pardalis*)
	Canidae	20/32 (62.5 %)	Gray wolf (*Canis lupus lupus)*, fennec (*Vulpes zerda*), maned wolf (*Chrysocyon brachyurus*)
	other families	1/7 (14.3 %)	Red panda (*Ailurus fulgens*)
Artiodactyla	Cervidae	33/54 (61.1 %)	Moose (*Alces alces*), milu (*Elaphurus davidianus*), wapity (*Cervus elaphus*)….
	Camelidae	9/18 (50 %)	Bactran camel (*Camelus ferus*), alpaca (*Lama guanicoe f. pacos*)
	Giraffidae	3/10 (30 %)	Giraffe (*Giraffa camelopardalis*)
	Bovidae	97/333 (29.1 %)	West Caucasian tur (*Capra caucasica*), Himalayan tahr (*Hemitragus jemlahicus*), American bison (*Bison bison*), sitatunga (*Tragelaphus spekei*), sable antelope (*Hippotragus niger*)
	Suidae	1/8 (12.5 %)	Eurasian wild boar (*Sus scrofa*)
	Hippopotamidae	0/2	
	Tragulidae	0/1	
Proboscidea	Elephantidae	5/9 (55.6 %)	African elephant (*Elephas africanus*), Indian elephant (*E. maximus*)
Perissodactyla	Equidae	30/80 (37.5 %)	Kiang (*Equus kiang*), Asian wild ass (*Equus hemionus*), Przewalski´s horse (*Equus przewalskii*), zebra
	Rhinocerotidae	4/18 (22.2 %)	Indian rhinoceros (*Rhinoceros unicornis*), white rhinoceros (*Ceratotherium simium*)
Hyracoidea	Procaviidae	1/8 (12.5 %)	Rock hyrax (*Procavia capensis*)

Continuation tab. 2

Order	Family	Positive/total (%)	*T. gondii* positive species
Primates		2/19 (10.5 %)	Orangutan (*Pongo abelii*)
Rodentia		2/26 (7.7 %)	South African springhare (*Pedetes capensis*), Patagonian mara (*Dolichotis patagonum*)
Tubulidentata	Orycteropidae	2/4	Aardvark (*Orycteropus afer*)
Diprotodontia	Diprotodontia	2/2	Red kangaroo (*Macropus rufus*), red-necked wallaby (*Macropus rufogriseus*)
Eulipotyphla		0/2	
Chiroptera		0/1	
Xenarthra	Myrmecophagidae	0/2	
Total		**245/688 (35.6 %)**	

Antibodies against *T. gondii* were detected in different groups of zoo animals. The results of this study indicate that *T. gondii* is fairly common in zoo animals in the Czech Republic and Slovakia. Based to these results, we can recommend some prevention rules such as to ensure frequent cleaning of felids´ cages and to remove their faeces, to prevent contact of zoo animals with wild birds and rodents that could transfer *T. gondii* infection. From the infection side of view it would be best not to feed raw meat to the carnivores, which of cause is hard to realise. It is highly suggested to continue with prevalence studies to know actual situation, to monitor possible shedding oocysts by felids and also to isolate DNA of *T. gondii* from tissues of animals with clinical symptoms or in fatal cases for genotyping *T. gondii* strains. Based to genotypes, we can compare these strains with genotypes isolated from domestic or wild animals, from animals of different zoos or different countries and it could help us to find the source of infection and explain possible ways of its transfer.

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