

Serological survey of Toxoplasmosis in South American coatis (*Nasua nasua*) in Tietê Ecological Park, São Paulo, SP, Brazil

Inquérito sorológico da Toxoplasmose em quatis (Nasua nasua) do Parque Ecológico do Tietê, São Paulo, SP, Brasil

Jéssica França MAIA¹; Solange Maria GENNARI²; Liliane MILANELO³; Haroldo Ryoiti FURUYA³; Vanessa Aparecida Feijó SOUZA¹; Sérgio Netto VITALIANO^{1,2}

¹Faculdades Metropolitanas Unidas, Curso de Medicina Veterinária, São Paulo – SP, Brazil

²Universidade de São Paulo, Faculdade de Medicina Veterinária e Zootecnia, Departamento de Medicina Veterinária Preventiva e Saúde Animal, São Paulo – SP, Brazil

³Centro de Recuperação de Animais Silvestres, Parque Ecológico do Tietê (CRAS-PET), Engenheiro Goulart – SP, Brazil

Abstract

Toxoplasma gondii is an obligate intracellular protozoan parasite that causes toxoplasmosis in humans, domestic animals and wild animals. Although there is serological evidence of *T. gondii* infection in wild animals, little is known about the role of wildlife in the epidemiological chain of this parasite. The South American coati (*Nasua nasua*) is an omnivorous species capable of adaptation to different environments. It can be found throughout Brazil, and in anthropized environments it can come into close contact with domestic animals. The present study found occurrences of *T. gondii* antibodies in South American coatis living in the Tietê Ecological Park, in the municipality of São Paulo, Brazil, through the modified agglutination test (MAT). In total, 99 samples were obtained and 70.70% (n = 70) were positive for anti-*T. gondii* antibodies, with titers that ranged from 50 to 3200. The data from this study indicate that South American coatis are exposed to this parasite.

Keywords: Serology. MAT. Wildlife. Toxoplasmosis.

Resumo

Toxoplasma gondii é um protozoário parasita intracelular obrigatório que causa a toxoplasmose em humanos, animais domésticos e selvagens. Apesar das evidências sorológicas da infecção por *T. gondii* em animais selvagens, pouco se sabe sobre o papel da vida selvagem na cadeia epidemiológica deste parasito. Os quatis (*Nasua nasua*) são uma espécie onívora capaz de se adaptar em diferentes ambientes. Eles são encontrados em todo território brasileiro, e em ambientes antropizados podem apresentar um contato próximo com animais domésticos. O presente estudo verificou a ocorrência de anticorpos anti-*T. gondii* em quatis habitantes do Parque Ecológico do Tietê, São Paulo, Brasil, pelo Teste de Aglutinação Modificada (MAT). No total, 99 amostras foram obtidas das quais 70,70% (n = 70) foram positivas para anticorpos anti-*T. gondii*, com títulos de anticorpos que variaram de 50 a 3200. Os dados obtidos neste estudo indicam que quatis sul-americanos são expostos a este parasito.

Palavras-chave: Sorologia. MAT. Vida selvagem. Toxoplasmose.

Correspondence to:

Sérgio Netto Vitaliano

Universidade de São Paulo, Faculdade de Medicina Veterinária e Zootecnia, Departamento de Medicina Veterinária Preventiva e Saúde Animal

Av. Prof. Dr. Orlando Marques de Paiva, 87, Cidade Universitária, Butantã

CEP 05508-270, São Paulo, SP, Brazil

e-mail: sergiovitaliano@yahoo.com.br

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Introduction

Toxoplasma gondii is an intracellular protozoan parasite capable of infecting several animal species including humans (DUBEY, 2010). Its infection is widely prevalent worldwide, particularly in Brazil, where the prevalence of *T. gondii* infection in humans is especially high and can reach 100% in some areas (DUBEY et al., 2012). Domestic cats and other felids are definitive hosts (FRENKEL et al., 1970), and vir-

tually all warm-blooded animals (birds and mammals) are intermediate hosts (DUBEY, 2010). Infection occurs after ingestion of food and/or water contaminated with oocysts from feces of infected cats or ingestion of undercooked meat containing tissue cysts from infected intermediate hosts (GENNARI et al., 2015).

Wildlife may play an important role in transmission and maintenance of *T. gondii* in the environment. However, only limited information on *T. gondii* circulating in wild animals is available in Brazil (YAI et al., 2009; DUBEY et al., 2011; PENA et al., 2011; CABRAL et al., 2013; CAÑÓN-FRANCO et al., 2013; VITALIANO et al., 2014a, 2014b).

The South American coati (*Nasua nasua*), also known as coatimundi, is a gregarious species within the family Procyonidae (which also include raccoons) and is widely distributed in South America (EMMONS; HELGEN, 2016). It occurs in Colombia, Venezuela, Guyana, Suriname, Peru, Bolivia, Argentina, Uruguay, Paraguay and Brazil (BITTNER et al., 2010), where it is often the most abundant species of the order Carnivora (GOMPPER; DECKER, 1998). Due to habitat losses, this species commonly lives in urban forests, traveling between wild and domestic areas (RODRIGUES et al., 2006).

South American coatis are medium-sized omnivorous animals that feed on fruit, small vertebrates and forest-floor invertebrates (GOMPPER; DECKER, 1998; ALVES-COSTA et al., 2004), occasionally consuming larger prey (REIS et al., 2006). There are also records of necrophagous diets and, in areas of anthropogenic influence, they are often observed feeding on garbage (RODRIGUES et al., 2006; CUNHA, 2010).

Procyonid species are reservoirs of several human and domestic animal pathogens. In Brazil, South American coatis are found naturally infected with different zoonotic parasites, such as *Trypanosoma cruzi*, *Amblyomma cajennense* (the main vector of *Rickettsia rickettsii*), *Toxoplasma gondii* and others (MINERVINO et al., 2010; ALVES et al., 2011; SILVA

et al., 2014; WITTER et al., 2016). Despite their wide geographical distribution, relative abundance and etiological interest, most of the data concerning this species are focused only on its behavior and ecology (BEISIEGEL, 2001), whereas only a few studies have addressed infectious diseases (HERRERA et al., 2008; ALVES et al., 2011; SILVA et al., 2014).

Considering the scant information about *T. gondii* infection in South American coatis, the present study aimed to investigate the occurrence of antibodies against these parasites in a population of South American coatis living in Tietê Ecological Park, located inside the municipality of São Paulo, state of São Paulo, Brazil.

Material and Methods

Serum samples from 99 South American coatis living in Tietê Ecological Park (23°29'31" S and 46°31'16" W), in the municipality of São Paulo, were obtained. Blood was collected by means of jugular venipuncture during population control neutering routine campaigns, from September 2009 to February 2013. The sampled animals live in a situation of semi-captivity. The South American coati groups remain free inside the park, but nutritional support is offered daily.

Serum samples were assayed for the presence of anti-*T. gondii* antibodies by means of the modified agglutination test (MAT), using formalin-fixed, RH-strain tachyzoites as the antigen. The samples were examined at dilutions of 1:25, 1:50 and 1:500. Titers of 1:25 or higher were considered indicative of *T. gondii* exposure. Positive samples were submitted to twofold serial dilutions to determine the final titer. The reading was made 12 hours after mixing the serum to the antigen. Display of a defined button at the base of the plate indicates a negative result, while the absence of the button or the formation of a complete carpet or a veil shape shows positive result (DUBEY; DESMONTS, 1987).

The association between gender, age and presence of antibodies against *T. gondii* were analyzed using the

chi-square test, P values < 0.05 were considered statistically significant (SPSS version 15.0, SPSS Inc., Chicago, IL, USA).

Results

Out of the total of 99 South American coatis, 70 (70.70%) were seropositive for *T. gondii*. The antibody titers ranged from 25 to 3200 and the most prevalent titer was 400, observed in 19 samples (Table 1).

Table 1 – Titers of antibodies against *Toxoplasma gondii* (MAT \geq 25) in South American coatis (*Nasua nasua*) from Tietê Ecological Park – São Paulo, SP, Brazil – 2009-2013

Titer	Nº of Animals	Occurrence (%)
25	9	12.86
50	16	22.86
100	14	20.00
200	9	12.86
400	19	27.14
800	2	2.86
3200	1	1.42
Total	70	100

Among the samples tested, 58 were from females, of which 45 (77.6%) were positive; and 25 samples were from males, of which 14 (56%) were positive for *T. gondii* antibodies (Table 2). In 16 samples, the gender was not identified: from this total, 11 samples (68.7%) were positive.

Table 2 – Occurrence of *Toxoplasma gondii* antibodies in serum samples of 99 South American coatis (*Nasua nasua*) from Tietê Ecological Park, São Paulo, SP, Brazil, according to the age and gender – 2009-2013

Age*	Examined	Positive	%
Young	7	2	28.6
Adult	78	59	75.6
NI	14	9	64.3
Gender**			
Female	58	45	77.6
Male	25	14	56.0
NI	16	11	68.7

* P value = 0.017, **P Value = 0.138, NI = not identified

Seropositivity for *T. gondii* was strongly related to age, with positivity rates significantly higher (p = 0.017) among adult coatis (75.6%) than among juvenile animals (Table 2).

Discussion

This study evaluated the presence of antibodies anti-*T. gondii* in a free-living population of South American coatis inhabiting Tietê Ecological Park, located in São Paulo municipality. Despite the free-living condition of these coatis, they can be considered to be synanthropic since they were being fed with a complementary source of food (fruit) provided by the park administration. Furthermore, the park is located within an urban area.

Several studies have reported the presence of antibodies to *T. gondii* in wild procyonids (SOGORB et al., 1977; DUBEY et al., 1993; HANCOCK et al., 2005; MINERVINO et al., 2010). The results from the present study corroborate this information about the widespread presence of antibodies against *T. gondii* in Brazilian wildlife in general (VITALIANO et al., 2004; ANDRÉ et al., 2010; MINERVINO et al., 2010; VITALIANO et al., 2014). In the present study, *T. gondii* antibodies were found in 70.70% of the animals sampled. Similar prevalence rates were found in French Guiana in a study conducted from 1994 to 1995. Among all the South American coatis sampled in that study, 72% were seropositive for *T. gondii* antibodies (THOISY et al., 2003). In a *T. gondii* survey on captive animals in northern and northeastern Brazil, six out of 11 coatis presented antibodies against this parasite (MINERVINO et al., 2010).

As observed here, other Procyonidae species also present high frequency of seropositivity for *T. gondii*. In the USA, 84% of the raccoons tested (*Procyon lotor*) were found to be positive for *T. gondii* (HANCOCK et al., 2005). In another study, 100% of the 12 raccoons tested were seropositive for *T. gondii* antibodies (MITCHELL et al., 2006). The high frequency of seropositivity for *T. gondii* antibodies that are found in Procyonids, and more specifically in South American coatis, are related to their omnivorous feeding habits. Omnivores can become infected either through environmental contamination or through consumption of parasite-harboring prey. Another important feature that may influence the seropositivity to *T. gondii* in coatis is vertical usage of space. Terrestrial and/or

terrestrial and arboreal species are more likely to become infected than are exclusively arboreal species because of the greater exposure of terrestrial species to feline feces than that of arboreal species. South American coatis have both arboreal and terrestrial habits and thus fit this exposure profile.

In the present study, the antibody titers ranged from 25 to 3200. The titers observed here were higher than the titers found in captive South American coatis in northern Brazil, which ranged from 50 to 800 (PIMENTEL et al., 2009; MINERVINO et al., 2010).

The rates of seropositivity for *T. gondii* were seen to increase with age. As observed in previous studies on procyonids and other wild mammal species, this is a common pattern for many host species and disease agents. As animals age, their cumulative likelihood of exposure to *T. gondii* increases (ZARNKE et al., 2000; VITALIANO et al., 2004; HWANG et al., 2007). However, no influence of gender on *T. gondii* infection was observed in the present study.

The results from the current study indicate that *T.*

gondii is endemic in the South American coati population in Tietê Ecological Park. Despite the high frequency of coatis presenting antibodies against *T. gondii* in South America, little is known about the pathogenicity of the parasite isolates found in this procyonid species. However, further studies should be developed in order to elucidate the real importance of these procyonids in the epidemiology of *T. gondii*.

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