ABSTRACT: The purpose of this study was to verify the occurrence of anti-Toxoplasma gondii antibodies in 51 wild animals at the Arruda Câmara Zoological-Botanical Park in João Pessoa, PB, Brazil. Blood samples from different bird, mammal and reptile species were analyzed using the Modified Agglutination Test (MAT) with a cut-off point of 1:25. Anti-T. gondii antibodies were detected in 62.4% of the 51 tested animals. The following frequencies were found: 68.9% (20/29) in mammals, 80% (8/10) in birds, and 33.3% (4/12) in reptiles. This paper reports for the first time the occurrence of anti-T. gondii antibodies in birds of the species Pionites leucogaster (caíque), Anodorhynchus hyacinthinus (hyacinth macaw), Pavo cristatus (Indian peafowl), Urubitinga urubitinga (Brazilian eagle), and Buteo melanoleucus (black-and-white hawk-eagle). Reptiles of the species Caiman crocodilus (spectacled caiman), Chelonoidis carbonaria (red-footed tortoise) and Paleosuchus palpebrosus (Cuvier’s dwarf caiman) were seropositive for T. gondii, although the significance of the presence of these anti-T. gondii antibodies in this group of animals requires a more in-depth study. We conclude that the frequency of antibodies found in the animals of this zoo is high and that the prophylactic measures that aim to diminish the environmental contamination by oocysts are necessary.

KEYWORDS: modified agglutination test; seroprevalence; Toxoplasma gondii; zoo animals; zoonosis.

RESUMO: Este trabalho teve como objetivo verificar a ocorrência de anticorpos anti-Toxoplasma gondii em 51 animais silvestres mantidos no Parque Zoobotânico Arruda Câmara, João Pessoa, Brasil. Para isso, foram avaliadas amostras sanguíneas de diferentes espécies de aves, mamíferos e répteis por meio do Teste de Aglutinação Modificado (MAT) com ponto de corte de 1:25. Dos 51 animais testados, 62,4% apresentaram anticorpos anti-T. gondii. Nos mamiferos, a frequência encontrada foi de 68,9% (20/29), em aves foi de 80% (8/10) e em répteis de 33,3% (4/12). Pela primeira vez é relatada a ocorrência de anticorpos anti-T. gondii em aves das espécies Pionites leucogaster (marianinha-de-cabeça-amarela), Anodorhynchus hyacinthinus (arara-azul-grande), Pavo cristatus (pavão), Urubitinga urubitinga (gavião-preto) e Buteo melanoleucus (água-chilena). Répteis das espécies Caiman crocodilus (jacare-torto) e Chelonoidis carbonaria (jabuti) e Paleosuchus palpebrosus (jacaré-anão) foram soropositivos para T. gondii, embora o significado da presença deses anticorpos anti-T. gondii precise ser mais bem estudado nesse grupo de animais. Conclui-se que é alta a frequência de anticorpos encontrados nos animais do zoológico estudado e que medidas profiláticas que visem diminuir a contaminação ambiental por oocistos são necessárias.

PALAVRAS-CHAVE: animais de zoológico; soroprevalência; teste de aglutinação modificada; Toxoplasma gondii; zoonoses.
Toxoplasma gondii is an important protozoan parasite that affects humans and domestic and wild animals (DUBEY; BEATTIE, 1988; MINERVINO et al., 2010). The main problem this parasite causes in humans is reported in pregnant women, in whom the infection during pregnancy can cause irreversible damage to the fetus and may even lead to miscarriage. In farm animals, the main damage caused by T. gondii is abortion and economic losses (TSUTSUI et al., 2005).

T. gondii infections in zoos are extremely important, since many animals living in captivity die without exhibiting characteristic symptoms, and also due to the risk of environmental contamination, since infected felids can eliminate millions of oocysts, thus representing a source of infection for the other animals and for visitors (CAMPS et al., 2008). Acute toxoplasmosis can kill wild life species such as Australian marsupials, New World monkeys, lemurs, cougars, canaries, antelopes and finches, among others (SEDLÁK; BÁRTOVÁ, 2006; CAMPS et al., 2008; DUBEY; BEATTIE, 1988).

Studies in Brazil and around the world have performed serological surveys of T. gondii in several animal species living in zoos (SILVA et al., 2001; PIMENTEL et al., 2009; CAMPS et al., 2008; MINERVINO et al., 2010). However, few studies have focused on T. gondii in wild birds of the Brazilian fauna, and it holds even truer in the case of reptiles, for which the literature is devoid of reports describing seropositive animals.

The purpose of this study was therefore to investigate the occurrence of anti-T. gondii antibodies in mammals, birds and reptiles at the Arruda Câmara Zoological-Botanical Park, in the state of Paraíba (7°11′40.99″S, 34°87′61.99″W), in northeastern Brazil (Fig. 1).

This research was approved by the Ethic Committee on Research of Universidade Federal de Campina Grande, under the protocol number 178b - 2014.

Blood samples of varying volumes were collected from 29 mammals, 10 birds and 12 reptiles, using a disposable syringe and needle. The samples were drawn by puncture of the venous occipitals or the jugular, ulnar, cephalic and femoral veins, according to the animal species. The blood was centrifuged to obtain serum and then stored at -20°C until processing. None of the animals was sick when the blood was collected.

Sera from the animals were tested for anti-T. gondii antibodies at the Faculty of Veterinary Medicine and Animal Science of the Universidade de São Paulo, using the Modified Agglutination Test (MAT) with tachyzoites inactivated, formalin

Figure 1. Map of the Arruda Câmara Zoological-Botanical Park localization, municipality of João Pessoa (PB), Brazil.
and 2-mercaptoethanolas described by DUBEY; DESMONTS (1987). Titers of 1:25 or higher were considered indicative of exposure to \textit{T. gondii}. Each battery of tests included positive and negative controls.

Of the 51 tested animals, 62.4\% presented anti-\textit{T. gondii} antibodies. In the mammals, antibodies were found in 68.9\% (20/29) of the tested animals, with titers ranging from 25 to 6,400 (Table 1). It was observed that all animals of the species \textit{Sapajus libidinosus}, \textit{Nasuanasua}, \textit{Coendu} sp., \textit{Rattus rattus}, \textit{Galictis vittata} and \textit{Tayassu tajacu} presented antibodies positive for \textit{T. gondii}.

The frequency of antibodies found in the birds was 80\% (8/10), with titers varying from 25 to 3,200 (Table 1). Only two species of birds were not positive for \textit{T. gondii}: \textit{Ara chloropterus} and \textit{Polyborus plancus}. For the first time the occurrence of anti-\textit{T. gondii} antibodies in birds of the species \textit{Pionites leucogaster} (caique), \textit{Anodorhynchus hyacinthinus} (hyacinth macaw), \textit{Pavo cristatus} (Indian peafowl), and \textit{P. plancus} (Southern crested caracara) was reported.

Table 1. Presence of anti-\textit{Toxoplasma gondii} antibodies (MAT \geq 25) in wild captive animals at the Arruda Câmara Zoological-Botanical Park in João Pessoa, northeastern Brazil.

<table>
<thead>
<tr>
<th>Animals species</th>
<th>No. examined/positive(%)</th>
<th>Titer range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mammals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black rat (\textit{Rattus rattus})</td>
<td>1/1 (100%)</td>
<td>400</td>
</tr>
<tr>
<td>Black-striped capuchin (\textit{Sapajus libidinosus})</td>
<td>5/5 (100%)</td>
<td>200–6,400</td>
</tr>
<tr>
<td>Greater grison (\textit{Galictis vittata})</td>
<td>2/2 (100%)</td>
<td>50–200</td>
</tr>
<tr>
<td>Hoary fox (\textit{Lycalopex vetulus})</td>
<td>2/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Coati (\textit{Nasua nasua})</td>
<td>5/5 (100%)</td>
<td>100–800</td>
</tr>
<tr>
<td>Collared peccary (\textit{Tayassu tajacu})</td>
<td>1/1 (100%)</td>
<td>400</td>
</tr>
<tr>
<td>Ocelot (\textit{Leopardus pardalis})</td>
<td>5/3 (60%)</td>
<td>1,600</td>
</tr>
<tr>
<td>Oncilla (\textit{Leopardus tigrinus})</td>
<td>5/2 (40%)</td>
<td>200–1,600</td>
</tr>
<tr>
<td>Porcupine (\textit{Coendou} sp.)</td>
<td>1/1 (100%)</td>
<td>25</td>
</tr>
<tr>
<td>Squirrel monkey (\textit{Saimiri sciureus})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Tayra (\textit{Eira Barbara})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Birds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black-and-white hawk-eagle (\textit{Buteo melanoleucus})</td>
<td>1/1 (100%)</td>
<td>25</td>
</tr>
<tr>
<td>Brazilian eagle (\textit{Urubitinga urubitinga})</td>
<td>1/1 (100%)</td>
<td>25</td>
</tr>
<tr>
<td>Caique (\textit{Pionites leucogaster})</td>
<td>1/1 (100%)</td>
<td>100</td>
</tr>
<tr>
<td>Hyacinth macaw (\textit{Anodorhynchus hyacinthinus})</td>
<td>1/1 (100%)</td>
<td>50</td>
</tr>
<tr>
<td>Indian peafowl (\textit{Pavo cristatus})</td>
<td>3/3 (100%)</td>
<td>25–3,200</td>
</tr>
<tr>
<td>Red-and-green macaw (\textit{Ara chloropterus})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Southern crested caracara (\textit{Polyborus plancus})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>White-browed quan (\textit{Penelope jacucaca})</td>
<td>1/1 (100%)</td>
<td>400</td>
</tr>
<tr>
<td><strong>Reptiles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amazon tree boa (\textit{Corallus hortulanus})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Argentine black and white tegu (\textit{Tupinambis merianae})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Broad-nosed caiman (\textit{Caiman latirostris})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Burmese python (\textit{Python molurus})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Cuvier’s dwarf caiman (\textit{Paleosuchus palpebrosus})</td>
<td>1/1 (100%)</td>
<td>800</td>
</tr>
<tr>
<td>Gold tegu (\textit{Tupinambis teguixin})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Red-footed tortoise (\textit{Chelonoidis carbonaria})</td>
<td>3/2 (66%)</td>
<td>100</td>
</tr>
<tr>
<td>Spectacled caiman (\textit{Caiman crocodilus})</td>
<td>1/1 (100%)</td>
<td>50</td>
</tr>
<tr>
<td>Toad head turtle (\textit{Bufocephaala vanderhaegi})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>Yellow-footed tortoise (\textit{Chelonoidis denticulata})</td>
<td>1/0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>51/32 (62.7%)</td>
<td>25–3,200</td>
</tr>
</tbody>
</table>
found no animal seropositive for *T. gondii* in 19 wild birds, such as that by MINERVINO et al. (2010), who tested positive.

Sapajus xanthosternus and *T. gondii* for anti-*T. gondii* antibodies. PIMENTEL et al. (2009) also reported 7.7% (8/104) of animals positive in MAT and also in the western blotting technique. The significance of the presence of anti-*T. gondii* antibodies in reptiles needs to be better investigated, since LAINSON et al. (1997) suggested that poikilothermic animals have natural immunity to infection, and several authors state that *T. gondii* is able to infect only warm-blooded animals (DUBEY, 2004; TENTER et al., 2000). According to FERREIRA et al. (2012), the paradigm that the parasite is able to infect only warm-blooded animals may have changed, in view of the serological evidence of infection by *T. gondii*. However, this hypothesis could only be confirmed by isolating the parasite from the tissues of poikilothermic animals.

The animals in the zoo of this study showed a high frequency of anti-*T. gondii* antibodies. Prophylactic measures zoo aimed at reducing the infection of these animals by *T. gondii* should be adopted, because, although most of them did not present clinical signs, some of these animals are highly susceptible and may die from toxoplasmosis, which is a serious problem for zoos, one of whose objectives is species preservation. Do not feed animals with fresh meat, freezing storage before meat consumption e controlling the access of synanthropic animals and domestic cats to zoo environments are important measures to prevent toxoplasmosis in zoo animals, although it is still a challenge for zoos.
REFERENCES


