Iheringia
Série Zoologia

e-ISSN 1678-4766
www.scielo.br/isz

Museu de Ciências Naturais
Fundação Zoobotânica do Rio Grande do Sul

Current status of ticks and tick-host relationship in domestic and wild animals from Pantanal wetlands in the state of Mato Grosso do Sul, Brazil

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Received 12 December 2016
Accepted 6 February 2017

DOI: 10.1590/1678-4766e2017110

ABSTRACT. This is a commented list of tick's species collected on various wild and domestic animals, including the reports on scientific literature for the studied region. Most of animals were small or medium mammals. Carnivores were the main taxa group examined. Although, the pampas deer (*Ozotocerus bezoarticus*) and giant anteater (*Mymercophaga tridactyla*) also has a good representation on study. Among domestic animals, dogs, horses and cattle were examined. Summing up, 18 tick species were listed for the region. Sixteen were hard ticks (Ixodidae) and two soft ticks (Argasidae). *Amblyomma sculptum* was the most common and abundant hard tick. *Ornithodoros rostratus* (Argasidae) was very abundant, being the more important Argasidae tick on the study region. The following species were colleted or reported on scientific literature: *Argas miniatus* Koch, 1844; *Ornithodoros rostratus* Aragão, 1911; *Dermacentor nitens* Newmann, 1897; *Rhipicephalus* (*Boophilus*) *microplus* Canestrini, 1887; *Amblyomma tigrinum* Koch, 1844; *A. dissimile* Koch, 1844; *A. ovale* Koch, 1844; *A. pauvum* Aragão, 1908; *A. sculptum* Berlese, 1888; *A. calcaratum* Neumann, 1899; *A. coelebs* Neumann, 1899; *A. dubittatum* Newmann, 1899; *A. scalpturatum* Newmann, 1906; *A. naponense* Packard, 1869; *A. nodosum* Newmann, 1899; *A. pseudoconcolor* Aragão, 1908; *A. rotundatum* Koch, 1844; *A. triste* Koch, 1844.

KEYWORDS. Nhecolândia, Argasidae, Ixodidae, Pantanal, Biota-MS Program.

RESUMO. Estado atual dos carrapatos em relação a seus animais-hospedeiros domésticos e selvagens do Pantanal no Estado do Mato Grosso do Sul, Brasil. Este artigo consiste de uma lista comentada das espécies de carrapatos coletadas em diversas espécies de animais selvagens e domésticos incluindo aquelas espécies já reportadas na região. Os animais capturados são em sua maioria mamíferos de pequeno e médio porte. Os carnívoros foi o grupo com maior número de observações. Entretanto, o veado campeiro (*Ozotocerus bezoarticus*) e o tamanduá bandeira (*Mymercophaga tridactyla*) também tiveram um número significativamente de amostras. Dentre os animais domésticos, cães, equinos e bovinos foram examinados. No total foram listadas 18 espécies de carrapatos para a região. Dezesseis delas são carrapatos duros (Ixodidae) e duas, carrapatos moles (Argasidae). Dentre os Ixodidae, *Amblyomma sculptum* foi a espécie mais encontrada, sendo considerada a mais abundante na região. *Ornithodoros rostratus* (Argasidae) mostrou-se frequente e abundante, sendo o principal representante da família. Somando as coletas com os resultados de literatura, as seguintes espécies foram catalogadas para a região: *Argas miniatus* Koch, 1844; *Ornithodoros rostratus* Aragão, 1911; *Dermacentor nitens* Newmann, 1897; *Rhipicephalus (Boophilus) microplus* Canestrini, 1887; *A. tigrinum* Koch, 1844; *A. dissimile* Koch, 1844; *A. ovale* Koch, 1844; *A. parvum* Aragão, 1908; *A. sculptum* Berlese, 1888; *A. calcaratum* Neumann, 1899; *A. coelebs* Neumann, 1899; *A. dubittatum* Newmann, 1899; *A. scalpturatum* Newmann, 1906; *A. naponense* Packard, 1869; *A. nodosum* Newmann, 1899; *A. pseudoconcolor* Aragão, 1908; *A. rotundatum* Koch, 1844; *A. triste* Koch, 1844.

PALAVRAS-CHAVE. Nhecolândia; Argasidae; Ixodidae; Pantanal; Programa Biota-MS.

The Brazilian Pantanal wetland is the largest seasonal floodplain in the world and the major economic activity is cattle production. Brazil is the largest exporter of bovine beef in the world and the Pantanal region plays a key role in beef cattle production. Moreover, Pantanal is considered a hotspot for conservation by UNESCO. The Pantanal is undergoing major transformation due to changes in cattle management and introduction of alien species leading to more productive pastures and consequently increasing bovine density. Host-parasite relationship in natural habitats has resulted from a long period of co-evolution and, in most cases, interactions are complex and in equilibrium, such as among ticks, hosts and tick-borne-diseases.

Environmental changes and habitat fragmentation are being pointed out as the primary cause for the loss of biodiversity (McCallum & Dobson, 2002). Along with the

high-speed development of cattle production and ecotourism, these circumstances have made the Pantanal into a hotspot for emerging and re-emerging parasitic diseases. Cançado *et al*. (2008, 2009) showed different aspects of the impact of cattle production on tick populations in the field and some implication for wildlife in the Pantanal. Few studies have been conducted in the Pantanal concerning ticks and tick-borne diseases. Therefore, tick fauna and its potential to transmit or maintain disease are almost unknown. Nevertheless, the following papers show a huge diversity of ticks (Machado *et al*., 1985; Ito *et al*., 1998; Pereira *et al*., 2000; Martins *et al*., 2004; Labruna *et al*., 2005; Cançado *et al*., 2008) and the introduced *Rhipicephalus (Boophilus) microplus* (Canestrini, 1887) has been found on wild animals (Ito *et al*., 1998; Pereira *et al*., 2000; Cançado *et al*., 2009), although most of these papers were based on occasionally collected samples and did not allow adequate analysis of the dynamics of the environment and tick-host relationships.

This paper aims to gather information on tick-host relationships in the Pantanal and provides an updated list of species based on collected ticks and on scientific literature. Comments concerning each tick species based on field observations have also been included.

MATERIAL AND METHODS

Studied area. Research was carried out in southern Pantanal (Nhecolândia's sub-region – 19°08'28''S and 56°49'23''W). The field laboratory and base camp was located at Nhumirim ranch at EMBRAPA Pantanal. The region is characterized by sandy soil with a mosaic vegetation of semi-deciduous forest, dispersed shrub vegetation and seasonally flooded fields (Rodela *et al*., 2008). The region has two seasons, a wet season (October to March - 70% rain) and a dry season (April to September). The annual average temperature is 25.5°C and relative humidity (RH) is approximately 75% throughout the year. A detailed description of this region can be found in Soriano *et al*. (1997).

Capturing and handling procedures. The following domestic animals were examined: bovines, dogs, horses and chickens. Authorization for handling domestic animals was granted by owners. Procedures for wild animals are presented below. After proper handling, animals were ear-tagged. All procedures were authorized by the Brazilian Institute of the Environment (IBAMA) under licenses 026/2005, 032/2005 183/2005– 003/2006. Ethical guidelines for animal research from Colégio Brasileiro de Experimentação Animal (COBEA) were followed as well as the Guidelines for Capture, Handling and Care of Mammals approved by the American Society of Mammalogists (Animal Care and Use Committee 1998).

Ticks on wild animals. In general, all ticks encountered on animals following anesthesia were collected. Ticks were only partially collected from the giant-anteater due to the enormous number of ticks encountered. Nymphs and adult ticks were captured by hand only and larvae were collected by hand as well as using a soft toothbrush. A small number of larvae were destroyed by this kind of collection, making them impossible to identify.

Feral pigs. Feral pigs (*Sus scrofa* Linnaeus, 1758) were captured by fence traps or by cowboys using ropes to catch them with. All captured pigs were tranquilized (tiletamine hydrochloride and zolazepan hydrochloride, Zoletil®, Virbac) prior to examination for tick collection.

Carnivores. Captured carnivores included the brown-nosed coati (also known as the Brazilian aardvark, *Nasua nasua* Linnaeus, 1766), the crab-eating fox (*Cerdocyon thous* Linnaeus, 1766), the ocelot (or dwarf leopard, *Leopardus pardalis* Linnaeus, 1758) and the crab-eating raccoon (known as *mão pelada* in portuguese, *Procyon cancrivorus* Cuvier, 1798) were captured. With exception to *P. cancrivorus*, a live animal wire box trap (1 m x 0.40 m x 0.50 m - Zootec®) baited with bacon, fruits or fish was used. Individuals were anesthetized with an intramuscular injection of Zoletil®50 (Virbac®; tiletamine hydrochloride and zolazepan hydrochloride). The dose of anesthetics was determined by Rocha (2006). Other host species captured by these traps were the agouti (*Dasiprocta azarae* Lichtenstein, 1823), the six-banded armadillo (*Euphractus sexcintus* Linnaeus, 1758) and the collared-anteater (*Tamandua tetradactyla* Linnaeus, 1758).

Procyon cancrivorus were only captured at night using high-power lights and nets. The process of capture included searching for animals near lakes by pointing lights and searching for their eyes. When an animal was found, two people would shine the lights in its eyes to block its view while a third person would use the net to catch it. Apart from its capture, anesthesia and other procedures were the same as those for other carnivores.

Giant-anteater (*Mymercophaga tridactyla* Linnaeus, 1758). As this species has restricted variety but abundant food and is easy to locate, it was captured by nets. To locate these animals a motorized vehicle was used and when found it was approached by slowly walking followed by running. The dose of anesthetics was calculated according to manufacturer's recommendations for this species.

Collared anteater (*Tamandua tetradactyla*). These animals were only captured occasionally when they were located in "easy to catch" situations or accidentally captured by the live animal wire box trap. Handling procedures included the use of leather gloves for researcher's protection. Other procedures followed the same protocol as those used for the giant-anteater.

Pampas deer (*Ozotoceros bezoarticus* Linnaeus, 1758). Procedures used for the pampas deer are described in Piovezan *et al*. (2006) and Cançado *et al*. (2008).

Small mammals. Small mammals were captured by using two different kinds of traps: Shermann© and Tomahawk©. We prepared a mixture of bacon, nuts and vegetable oil to use as bait. These traps were set up at different areas of Nhumirim ranch, some directly on the ground and others in trees for the capture of both ground and arboreal species. For handling procedures, cotton bags and gloves were used and no anesthetic procedures were necessary for

most of these mammals. Research focused on two species of rodents, *Thrichomys* spp. e *Clyomys* spp.

Snakes (*Bothrops matogrossensis* Amaral, 1925). On some occasions, especially when snakes were found near schools or houses, locals would kill them for their own protection. In these cases, snakes were examined for ticks.

Observations on humans. During all field trips we collected ticks attached to either the researchers or locals.

Tick storage. Engorged ticks were kept alive in a high relative humidity chamber (>70%) to allow females to lay eggs and immature ticks to molt. These chambers were made of small plastic boxes with a humid cotton ball inside and holes made with needles to allow air exchange. All others ticks were maintained in glass flasks with 70% ethyl alcohol and labeled with the date and host number.

Tick identification. All ticks were identified by comparing morphological aspects using the most recent identification keys for Neotropical ticks (Guimarães *et al*., 2001; Barros-Battesti *et al*., 2006). Immature stages were identified for genus only.

Some representative ticks for each host species were sent to the Acarology Collection of the Butantan Institute, São Paulo, SP, Brazil (IBSP).

RESULTS

***Argas miniatus* Koch, 1844**. This argasid tick was collected in two different opportunities in the same chicken shed on a Ranch (19°08'28"S, 56°49'3"W). This was done by chance when the owner called for veterinary assistance to investigate chicken deaths. Ticks were collected and treatment was recommended. After a few weeks, egg production was shown to increase while deaths ceased. Eight months later a lighter infestation occurred in the same chicken shed. One probable source for the reinfestation was wild birds.

The collected ticks were sent to the Laboratory of Ixodology at UFRRJ where they were allowed to feed on chickens. Tick hemolymph and chicken blood were examined under a microscope and no pathogens were observed. The importance of this tick species is not clearly known, however, losses in productivity due to blood feeding, transmission of pathogens such as *Borrelia anserine* and paralysis induced by larvae in young birds have been reported (Santos *et al*., 2010). Because of the great abundance and diversity of wild birds in close contact with domestic animals in the Pantanal region, further research on the host-relationship of this tick is recommended.

***Ornithodoros rostratus* Aragão, 1911**. This tick species was first identified on feral pigs. On this occasion, four nymphs were collected. In the Laboratory of Ixodology (UFRRJ), these nymphs were placed to feed on domestic pigs to initiate a colony. After colony establishment, ticks were allowed to feed on rabbits under laboratory conditions.

In the Pantanal, we found *O. rostratus* feeding on dogs which are often found resting near residences on sand soils protected from sunlight by trees. Associated ecchymosis-like lesions were seen on the dogs' belly. When local residents where asked about the ticks, they complained about fever, red ecchymosis-like spots, lymph node swelling and itch following a tick bite.

One hundred fourteen specimens of *O. rostratus* were collected by CO_2 tick trap in a calf pen during a two hour trap effort (Cançado *et al*., 2008). The floor of the pen consisted of a mixture of soft sand soil, leaves and dry bovine feces. Bovines were maintained in the pen for two hours in the morning before milking. During milking, dogs owned by locals entered the pen.

Partial information on the life cycle can be found in (Guglielmone & Hadani, 1980). In some countries, species of *Ornithodoros* have a major role in disease transmission, such as borreliosis and typhus (Hoogstraal, 1985). Since the 1930s, this tick is known as vector of important tick-borne diseases, such as Brazilian Spotted Fever in humans (Lemos-Monteiro *et al*., 1932; Labruna, 2009). Nevertheless, massive experimental research is necessary to clarify the role of *O. rostratus* in the epidemiology of tick-borne diseases of cattle, humans and wildlife.

***Dermacentor nitens* (Neumann, 1897)**. This species is known to widely affect horses. It can be found inside ears, at the tail base, nostrils and mane (Borges & Leite, 1993; Guglielmone *et al*., 2006). In the Pantanal region, horses have enormous significance to cattle management efforts and consequently to the local economy. *Dermacentor nitens* is vector of the protozoan *Babesia caballi*. A total of 51 ticks were collected on 12 out of 21 horses (Tab. I). Three of these horses have lost one or both ears after massive tick infestations.

***Rhipicephalus (Boophilus) microplus* (Canestrini, 1887)**. We found *R. microplus* in two examined species of ruminants; cattle and pampas deer (*O. bezoarticus).* Pereira *et al*. (2000) and Labruna *et al*. (2005a) found this tick on wild animals in the Pantanal, and the deer was the most common wild host (Tab. II). One hundred seventy four bovines, of which 20 *Bos indicus* Linnaeus, 1758 (nelore) and 124 *Bos taurus* Linnaeus, 1758 (adapted breed, tucura) were searched. The prevalence of 43% was considered high and the rate of ticks per bovine was 0.58 ticks/animal (Tab. I). On the other hand the pampas deer have 76% prevalence and the rate of ticks was 9.7 ticks/animal (Cançado *et al*., 2009).

The pampas deer's antler growth occurs during the beginning of the dry season and requires a great energy investment (Tomas, 1995). In this period, the deer are in poor health conditions in which lower resistance possibly accounts for the apparent increase in tick population (Cançado *et al*., 2009). Ticks have been found around the base of growing antlers in an area of high blood flow. The biological importance of this tick behavior is unknown and more researches are necessary to clarify this issue.

In addition, the pampas deer (*O. bezoarticus*) probably play an important role in the epidemiology of *Anaplasma* spp. in the Pantanal (Picoloto *et al*., 2010). Since 1985, researchers have warned about the importance of studying the pampas deer as a reservoir for cattle diseases (Machado *et al*. 1985; Serra-Freire *et al*., 1996; Ito *et al*., 1998).

Tab. I. Domestic hosts: Prevalence (%) and number of ticks collected per host species in southern Pantanal (N, number of hosts examined; l, *Amblyomma* larvae; nn, *Amblyomma* nymphs).

Hosp./N	Prevalence/number of ticks							
	l	n	*A. cajennense*	*A. parvum*	*A. ovale*	*D. nitens*	*R. (B.) microplus*	*O. rostratus*
bovine/174	0	0	2%/4	1%/2	0	0	36%/96	0
horses/21	0	0	43%/18	0	0	57%/51	0	0
pigs/06	0	0	100%/24	0	0	0	0	0
dogs/24	12%/79	38%/42	25%/7	21%/18	17%/4	0	0	21%/6

Tab. II. List of the *Amblyomma* ticks and the hosts' relationships found in the Pantanal, Mato Grosso do Sul, Brazil. [A, collected data; B, based on the major Brazilian scientific collections (Onófrio, 2007); C, bibliography (Machado *et al*., 1985; Ito *et al.*, 1998; Pereira *et al*., 2000; Martins *et al*., 2004, Labruna *et al*., 2005); *, new parasitic relationship to the Pantanal area].

Tick species	Host species	Host common names	Records
A. sculptum	*Canis familiaris*	domestic dog	A, B, C
	Cerdocyon thous	crab-eating fox	
	Procyon cancryvorus	crab-eating raccon	
	Panthera onca	puma	
	Puma concolor	jaguar	
	Leopardus pardalis	oncelot	
	Nasua nasua	brown-nose coati	
	Masama guazoubira	catingueiro deer	
	*Ozotoceros bezoarcticus**	pampas deer*	
	Blastoceros dichotomus	marsh deer	
	Hydrochoeris hydrochoeris	capybara	
	Dasiprocta azarae	agouti	
	Trichomys sp.*	small rodent*	
	Equus caballus	horse	
	Tapirus terrestris	tapir	
	Bos taurus/B. indicus	bovine	
	Sus scrofa	feral/domestic pig	
	Tayassu pecari	queixada pig	
	*Tayassu tajacu**	caititu pig*	
	Mymerpophaga tridactyla	giant ant-eater	
	Tamandua tetradactyla	collared ant-eater	
	Dasypodidae	armadillo	
	Coendou prehensilis	hedgehog	
	Homo sapiens sapiens	humans	
A. calcaratum	*M. tridactyla*	giant ant-eater	B
	T. tetradactyla	collared ant-eater	
A. coelebs	*P. onca*	puma	B, C
	P. concolor	jaguar	
	T. terrestris	tapir	
	T. pecari	queixada pig	
	T. tajacu	caititu pig	
	*Chelonoidis carbonaria**	tortoise*	
A. dissimilie	*Bothrops matogrossensis*	jararaca snake	A, B
	Amphibia	amphíbians	
A. dubitatum	*C. thous*	crab-eating fox	B
	M. guazoubira	catingueiro deer	
	H. hydrochoeris	capybara	
	T. terrestris	tapir	
A. scalpturatum	*M. tridactyla*	giant ant-eater	C
	C. familiaris	domestic dog	
A. naponense	*S. scrofa*	feral/domestic pig	B
	T. pecari	queixada pig	
	T. tajacu	caititu pig	
	H. sapiens sapiens	humans	
A. nodosum	*M. tridactyla*	giant ant-eater	B, C
	T. tetradactyla	collared ant-eater	
A. ovale	*C. familiaris*	domestic dog	A, B, C
	Felis catus	domestic cat	
	C. thous	crab-eating fox	
	P. cancryvorus	crab-eating raccon	
	P. onca	puma	
	P. concolor	jaguar	
	L. pardalis	oncelot	

Tab. II. Cont.

Tick species	Host species	Host common names	Records
	Nasua nasua	brown-nose coati	
	Masama americana	bush deer	
	T. terrestris	tapir	
	H. sapiens sapiens	humans	
	C. familiaris	domestic dog	
	*C. thous**	crab-eating fox*	
	*P. cancryvoros**	crab-eating raccon*	
	P. onca	puma	
	P. concolor	jaguar	
	*L. pardalis**	oncelot*	
	Nasua nasua	brown-nose coati	
	M. guazoubira	catingueiro deer	
	M. americana	bush deer	
A. parvum	*O. bezoarcticus**	pampas deer*	A; B; C
	H. hydrochoeris	capybara*	
	*D. azarae**	agouti	
	*Trichomys sp.**	smmal rodent*	
	T. terrestris	tapir	
	*Bos taurus/ B. indicus**	bovine*	
	*S. scrofa**	feral / domestic pig*	
	*T. tajacu**	caititu pig*	
	M. tridactyla	giant ant-eater	
	T. tetradactyla	collared ant-eater	
	H. sapiens sapiens	humans	
A. pseudoconcolor	*Dasypodidae*	armadillo	C
A. rotundatum	*Reptilia*	reptiles	B
	Amphibia	amphibians	
	C. familiaris	domestic dog	
	C. thous	crab-eating fox	
	P. onca	puma	
A. tigrinum	*P. concolor*	jaguar	A, B, C
	Nasua nasua	brown-nose coati	
	B. dichotomus	marsh deer	
	Homo sapiens sapiens	humans	
	C. familiaris	domestic dog	
	P. onca	puma	
	P. concolor	jaguar	
A. triste	*B. dichotomus*	marsh deer	B
	H. hydrochoeris	capybara	
	T. terrestris	tapir	
	Bos taurus/ B. indicus	bovine	
	M. tridactyla	humans	

Tab. III. Wild hosts: Prevalence (%) and number of ticks collected per host species in southern Pantanal (N, number of hosts examined; ll, *Amblyomma* larvae; nn, *Amblyomma* nymphs).

Hosp.	N	Prevalence/number of ticks				
		ll	nn	*A. sculptum*	*A. parvum*	*A. ovale*
C. thous	42	21%/50	60%/271	17%/13	50%/65	14%/10
N. nasua	37	27%/123	76%/211	11%/6	48%/52	48%/46
P.cancryvorus	2	50%/1	50%/11	50%/3	100%/27	100%/15
L. pardalis	18	50%/234	3%/1	3%/8	88%/98	3%/1
S. scrofa	42	0	2%/1	100%/259	14%/8	0
T. tajacu	3	0	100%/20	100%/13	100%/11	0
D. azarae	4	0	100%/13	25%/3	50%/3	0
Thrychomys	37	100%/123	94%/188	0	8%/3	3%/1
M. tridactyla	17	40%/58	100%/332	94%/138	47%/17	6%/1
T. tetradactyla	3	33%/1	33%/3	66%/7	100%/5	0

***Amblyomma tigrinum* Koch, 1844**. Only one *A. tigrinum* male was found on 42 foxes, 37 coatis and 24 dogs surveyed, indicating low prevalence of this tick in the studied region. This tick species was found elsewhere on coati (*N. nasua*), puma (*Puma concolor*) and jaguar (*Panthera onca*) (Pereira *et al*., 2000; Onófrio, 2007).

***Amblyomma dissimile* Koch, 1844**. This tick is specialized in feeding on cold-blooded animals primarily reptiles (Barros-Battesti *et al*., 2006). Four tortoises (*Chelonoidis carbonaria* Spix, 1824) and seven snakes ("jararaca" - *Bothrops matogrossensis*) were examined. Adult ticks (*A. dissimile*) were found on two tortoises and three snakes.

A total of 16 adults were collected on snakes and one of them was parasitized by five *Amblyomma* spp. larvae. On the tortoise, ticks were found on its legs, near the body and protected by the carapace. This species was also found feeding on amphibians in the Pantanal and was reported to feed on humans (Onófrio, 2007).

***Amblyomma parvum* Aragão, 1908**. One of the most abundant and widely distributed species in the Nhecolandia region of the Pantanal is *A. parvum*. This tick has low specificity during all stages of the life-cycle, including the adult stage. It was collected from almost all examined host species including all wild and domestic carnivores (*P. cancrivorus*, *N. nasua*, *L. pardalis*, *C. thous* and *C. familiaris*), small (*Thrichomys* spp., *Clyomys* sp., *D. asarae*) and big rodent (*Hydrochoeris hydrochoeris*), bovines, feral and domestic pigs, collared peccary (*Tayassu tajacu*), giant ant-eater (*M. tridactyla*) and collared ant-eater (*T. tetradactyla*). This tick species has also been reported on puma and jaguar (*P. concolor* and *P. onca*), different species of deer (*Masama americana* and *M. guazoubira*) and tapir (*Tapirus terrestris*) (Tabs I-III). *Amblyomma parvum* nymphs were found feeding on all examined host species. It is worth noting the high number of engorged nymphs found on small rodents which molted to adults. A total of 87% (n=201) of nymphs from small rodents (*Thrichomys* spp.; *D. asarae*) molt to *A. parvum* adults. In Argentina, the rodent *Galea musteloides* (Caviidae) is classified as the major host for immature *A. parvum* (Nava *et al*., 2006).

Moreover, *A. parvum* was frequently found feeding on humans, which had also been previously described by other authors from Argentina and Brazil (Guglielmone *et al*., 2006, Szabó *et al*., 2007). Different from *A. sculptum*, the *A. parvum* bites do not hurt, allowing this tick to attach and feed for long periods without being noticed. Thus, it amplifies the risk of transmission of some tick-borne diseases, such as rickettsiosis. The first identification of a *Rickettsia* sp. from *A. parvum* was performed by Pacheco *et al*. (2007). It is interesting to note that two engorged nymphs, collected on humans molted to adults.

Amblyomma parvum has a wide geographic distribution, occurring in several Brazilian states and in different environments such as rainforest and savanna (Mullins *et al*., 2004; Szabó *et al*., 2007), as well as environments with milder weather such as northern Argentina.

***Amblyomma ovale* Koch, 1844**. This species was frequently found in the Pantanal. A total of 83 adult ticks were collected of which 42 were males and 41 females from 123 animals: two raccoons (*P. cancrivorus*) 18 ocelots (*L. pardalis*), 24 dogs (*C. familiaris*), 37 coatis (*N. nasua*) and 42 foxes (*C. thous*). Nymphs collected on small rodents (*Thrichomys* spp.) after ecdysis were identified as *A. ovale* (Tab. III). The scientific literature also includes the puma (*P. concolor*), jaguar (*P. onca*), ocelot (*L. pardalis*) and the domestic cat (*F. catus*) in the list of hosts for *A. ovale* in the Pantanal (Tab. II). These data strongly suggest that carnivores are the primary hosts for adult ticks. Specimens have been found on deer (*M. americana*) and tapir (*T. terrestris*) (Onofrio, 2007), although these findings appear to be accidental.

Some bioagents are associated with *A. ovale*. Forlano *et al*. (2005) included this species as a potential vector of *Hepatozoon canis*, from experimental studies. There are no studies of this agent in the Pantanal, however it should be noted that there are some findings of *H. canis* and *H. procyonis* in wild carnivores (*P. cancrivoros* and *N. nasua*) in other regions of Brazil (Massard & Massard, 1978; Schneider, 1968; Rodrigues, 2005). Labruna *et al*., (2004) found an infection rate of 28% *Rickettsia bellii* in *A. ovale* in the Amazon region, although *R. bellii* is regarded as nonpathogenic. Finally, the constant introduction of dogs from urban centers in the Pantanal region might favor the introduction of biological agents endangering native fauna.

***Amblyomma cajennense* (Fabricius, 1787)**. After the reassessment of the taxonomic status and distribution of *A. cajennense* in Brazil (Nava *et al*. 2014; Estrada-Peña *et al*., 2014; Martins *et al*., 2016) we assume that all records from Brazilian Pantanal are *A. sculptum*. Moreover, we review our field samples and all ticks are *A. sculptum*. The distribution of *A. sculptum* in Brazil generally encompass the entire Cerrado and Pantanal biomes and great part of the Atlantic forest biome (Martins *et al*., 2016).

The importance of this tick is due to its wide geographic distribution, low host specificity and proven role in the epidemiology of the Brazilian Spotted Fever. In the studied area, it was the most abundant species within samples collected in the environment (Cançado *et al*., 2008) and also on all hosts examined (Tab. II), particularly on the carnivores studied (Tab. III). In addition, species such as the giant-ant-eater and feral pigs are extremely parasitized by this species with 100% prevalence and high infestation intensity (more than 30 tick per animal).

The great importance of this species is due to its low specificity, high abundance and wide geographic distribution (Barros-Battesti *et al*., 2006). Furthermore, its role as an experimental vector of *Ehrlichia ruminantium* (*Cowdria ruminantum*) in the Antilles highlights the importance of monitoring this agent in the Pantanal, a reproductive hotspot for dozens of migrating birds that may aid in tick dissemination.

The fact that *A. sculptum* has been found parasitizing a wide variety of native wildlife species make their control

very difficult with the currently available technologies. Environmental control by acaricides would be catastrophic because of the impact on the regional biodiversity and contamination of water samples. There are no studies about the importance of *A. cajennense* in livestock production in the Pantanal.

***Amblyomma calcaratum* Neumann, 1899**. The adult stage seems to be associated exclusively with anteaters, however, immature stages are frequently found on birds. It has wide geographic distribution occurring from Argentina to Panama. (Barros-Battesti *et al*., 2006). Although *A. calcaratum* has been identified in the Pantanal (Onófrio, 2007) parasitizing two species of anteaters (*M. tridactyla* and *T. Tetradactyla*). Martins *et al*. (2004) did not find this species on this host. In the present study, we sampled ticks from 17 giant- and 3 collared-anteaters and no *A. calcaratum* were found. It is likely that this species is rare in the region or is restricted to limited environments, such as gallery forests, which were not sampled. However, the great similarity of *A. calcaratum* and *A. nodosum* should be considered and may contribute to misdiagnosis.

***Amblyomma coelebs* Neumann, 1899**. This species has been recorded in the Pantanal on peccary pig and queixada pig (*Tayassu pecari* and *T. tajacu*) and tapir (*Tapirus terrestris*) (Onófrio, 2007) and also on puma and jaguar (*P. onca* and *P. concolor*) (Labruna *et al*., 2005a; Onófrio, 2007). Although *A. coelebs* was not found in this survey, it is possible that it is present since tapirs are common and these were not examined.

***Amblyomma dubitatum* Neumann, 1899**. This species is mainly associated with capybaras (*H. hydrochoeris*). However, occasionally it can be found on different hosts (Barros-Battesti *et al*., 2006; Onófrio, 2007). This tick is important to the Brazilian Spotted Fever epidemiology because in many cases the occurrence of this disease is related to the presence of *A. dubitatum* and capybaras and this host is abundant in the Pantanal. The replacement of traditional cattle for grain crops such as soybeans, can favor the multiplication of capybaras that could become a pest. Ito *et al*. (1998) examined capybaras in the same region and the only tick species found was *A. sculptum*.

***Amblyomma scalpturatum* Newmann, 1906**. There is only one record of this species in the Pantanal. It was found parasitizing a giant-anteater (*M. tridactyla*) (Pereira *et al*., 2000), however, this tick species was not found in the present study. Thus, it is likely that this species is rare in the region or was an accidental finding.

***Amblyomma naponense* (Packard, 1869)**. The findings of this tick species in the Brazilian Pantanal are related to the order Artiodactyla: *S. scrofa*, *T. peccary* and *T. tajacu* (Onófrio, 2007). Despite the large number of sampled animals in this group (40), the species *A. naponense* was not found in the study region. Thus, it is likely to be restricted to other lowland regions.

***Amblyomma nodosum* Neumann, 1899**. The adults of this species are frequently found parasitizing the collared anteater or giant anteater (Martins *et al*., 2004). In the present study, this tick was not found. However, only three collared anteaters were examined.

***Amblyomma pseudoconcolor* Aragão, 1908**. This species was found parasitizing an armadillo (*E. sexcintus*) in the Nhecolândia sub-region (Pereira *et al*., 2000). Very little is known about *A. pseudoconcolor*. However, it appears that the immature stages can parasitize birds (Aragão, 1936). In the present study, all the ticks collected on armadillos were *A. cajennense*.

***Amblyomma rotundatum* Koch, 1844**. There are records of this species parasitizing reptiles and amphibians in the region. Its main feature is that biological females reproduce by parthenogenesis and the males are very rare (Labruna *et al*., 2005b). According to regional farm workers, it is common to see a "large tick" on cururu toads, although amphibians (Bufonidae) have been examined (25) no tick was found.

***Amblyomma triste* Koch, 1844**. This tick species has been found on different hosts. Onófrio (2007) listed records of scientific collections, which included: puma, jaguar, cattle, the marsh deer, tapir, capybara, and domestic dog as hosts. The main host of *A. triste* is most probably the marsh deer (*B. dichotomus*) (Szabó *et al*., 2003), however, it was not examined during the study.

Acknowledgements. To Fundação de Apoio ao Desenvolvimento do Ensino, Ciências e Tecnologia do Estado de Mato Grosso do Sul (Fundect) and Superintendência de Ciências e Tecnologia do Estado de Mato Grosso do Sul (Sucitec/MS) for the invitation to participate in this special issue of Iheringia, Série Zoologia and financial support for publication. We thank Dr. Manuel Venzal for your help in confirming the identification of ticks *Orniothodorus*.

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