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The first report of *Hepatozoon* spp. (Apicomplexa, Hepatozoidae) in domestic cats from São Paulo state, Brazil

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Abstract *Hepatozoon* sp. was diagnosed in three naturally infected cats from São Paulo state, Brazil. The first animal was admitted to the veterinary clinic with renal failure. During the hematological examination, gamonts of *Hepatozoon* sp. were observed within polymorphonuclear cells. Another two cats, which lived in the same house as the first cat, were also positive for this hemoparasite. This is the first report of a *Hepatozoon* sp. infection in domestic cats from Brazil.

Hepatozoon spp. are protozoan parasites that infect numerous domestic and wild carnivores, including canids, such as the domestic dog (James 1905), red fox (*Vulpes vulpes*) (Conceição-Silva et al. 1988), crab-eating fox (*Cerdocyon thous*) (Alencar et al. 1997), black-backed jackal (*Canis mesomelas*) (McCully et al. 1975), coyote (*Canis latrans*) (Davis et al. 1978; Mercer et al. 1988) and felids, such as bobcat (*Lynx rufus*) (Lane and Kocan 1983; Mercer et al. 1988), lions (*Panthera leo*), leopards (*Panthera pardus*) (Brocklesby and Vidler 1963; McCully et al. 1975; Averbeck et al. 1990), ocelots (*Felis pardalis*) (Mercer et al. 1988), Palas cat (*Felis manul*) (Barr et al. 1993), and cheetah (*Acinonyx jubatus*) (Averbeck et al. 1990). The infection of domestic cats was first described in India (Patton 1908). Since then, there have been few additional reports on this host (Baneth et al. 1998). This paper describes the first report of a *Hepatozoon* sp. infection of domestic cats in Brazil.

A 10-year-old male cat from Vargem Grande do Sul, São Paulo, Brazil was admitted to a veterinary clinic due to weight loss, lethargy, anorexia, polyuria, polydipsia, halitosis, diarrhea and vomiting over at least 7 days. During the clinical examination, the cat presented a normal temperature (38.4°C), normal respiratory and

cardiac frequency, but significant dehydration and high capillary perfusion. The animal also had cachexia, pale mucus, third eyelid protrusion, tongue ulcers and bilaterally enlarged submandibular lymph nodes. Examination of the cat's blood smears revealed gamonts of *Hepatozoon* sp. within some neutrophils (Fig. 1). The hematological abnormalities were marked anemia and leukopenia (Table 1). The serum biochemical abnormalities included extremely high urea and creatinine and elevated alkaline phosphatase and creatine kinase levels (Table 2). The diagnosis was acute renal insufficiency and, despite treatment, the animal died. Another two male cats, aged 10 and 4 years, which lived in the same residence as the first cat, were also positive for *Hepatozoon* spp. upon examination. These animals did not demonstrate abnormalities during the clinical and hematological examinations (Table 1). However, both cats presented high serum alkaline phosphatase and creatine kinase levels (Table 2).

The *Hepatozoon* sp. gamonts measured $9.88 \pm 0.39 \mu\text{m}$ in length, $5.3 \pm 0.19 \mu\text{m}$ in width, and $45.85 \pm 4.9 \mu\text{m}^2$ in area (Qwin Lite 2.5 computerized image analysis system, Leica). The three infected cats had fleas, but did not have ticks at the time of examination. The cats, however, lived in a rural area where they may have had contact with ticks.

Hepatozoon infection is well recognized in dogs, in which two species are described, *H. canis* and *H. americanum* (Vincent-Johnson et al. 1997). However, in cats the infection is poorly understood and the species remain to be determined (Baneth et al. 1998). Ewing (1977), during the necropsy of a cat with a diagnosis of monocytic leukemia, found many cigar-shaped, unicellular protozoa in the liver, identified as *Hepatozoon* sp. The clinical signs described were anorexia, weight loss, glossitis, pyrexia, oculonasal discharge and icterus and, in the blood examination, neutrophilia, monocytosis, anemia and azotemia were observed. The parasite was not detected in any tissues, including the blood, other than the liver, which could be considered as an atypical distribution for *Hepatozoon*. Van Amstel (1979)

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Fig. 1 *Hepatozoon* sp. gamont within a polymorphonuclear leukocyte from a cat from São Paulo state, Brazil (Giemsa-stained blood smear)

Table 1 Hemograms of cats naturally infected by *Hepatozoon* sp. from São Paulo state, Brazil. *RBC* Red blood cells, *MCV* mean corpuscular volume, *MCH* mean corpuscular hemoglobin, *MCHC* mean corpuscular hemoglobin concentration, *WBC* white blood cells

Parameters	Cat			Normal range (Jaim 1986)
	1	2	3	
RBC ($\times 10^6$)	3.25	8.9	8.7	5.0–10.0
Hemoglobin (g/dl)	6.0	11.2	10.2	8.0–15.0
Hematocrit (%)	18.0	39.0	30.0	24.0–45.0
MCV (fl)	55.4	43.8	34.5	39–55
MCHC(g/dl)	33.3	28.7	34.0	30–36
WBC (μ l)	4,500	15,000	12,500	5,500–19,500
Neutrophils (μ l)	3,420	9,750	8,000	3,500–7,500
Lymphocytes (μ l)	630	4,500	3,125	2,000–5,500
Monocytes (μ l)	450	0	250	100–400
Eosinophils (μ l)	0	750	1,125	200–1,200

Table 2 Serum biochemistries of cats naturally infected by *Hepatozoon* sp. from São Paulo state, Brazil. *AP* Alkaline phosphatase, *ALT* alanine aminotransferase, *CK* creatine kinase

Parameters	Cats			Normal range (Kaneko 1989)
	1	2	3	
Urea (mg/dl)	576.9	45.6	65.3	42.8–64.2
Creatinine (mg/dl)	9.5	0.8	0.8	0.8–1.8
A P (IU/l)	109.3	107.5	129.3	25–93
ALT (IU/l)	84.1	-	-	6.0–83.0
Albumin (g/dl)	2.6	2.5	-	2.1–3.3
CK (IU/l)	110.5	57.3	61.9	7.2–28.2

described lethargy, anorexia, stomatitis, gingivitis and pyrexia in a cat with *Hepatozoon* gamonts. Baneth et al. (1998) performed a retrospective study of hepatozoo-

nosis in cats over a 7-year period (1,229 animals). *Hepatozoon* gamonts were identified in seven cats (0.57%), with ages varying from 1 to 6 years. Infected cats were mostly males (6/7) with a variety of complaints and clinical signs. The authors remarked on two interesting findings from their study: the elevated levels of muscle enzymes found in the blood of parasitemic cats—5 of 6 had increased activities of serum lactate dehydrogenase (LDH) and creatine kinase (CK)—and the high prevalence of retroviral infection in cats with hepatozoonosis (4/6 cats had FIV or FELV infections).

In this study, the first cat was debilitated with renal failure the clinical signals of which could not be attributed to a *Hepatozoon* sp. infection. However, the three cats had elevated levels of creatine kinase, which is suggestive of skeletal muscle lesions. This finding was also observed by Baneth et al. (1998) and may be explained by the study of Klopfer et al. (1973), who detected *Hepatozoon*-like schizonts in the lumina of myocardial blood capillaries of cats from Israel. In addition, the three animals had high levels of alkaline phosphatase, which is a common finding in dogs with hepatozoonosis and may be related to the presence of developmental stages in the liver (Baneth and Weigler 1997). Two of the infected cats did not present any clinical abnormalities and it is possible that the infection in cats has a low virulence, which might be associated with concurrent disease, similarly to *H. canis* infection in dogs (Baneth and Weigler 1997). Interestingly, two of the cats were older animals (10 years), which may also indicate a chronic and mild infection. The fact that three animals from the same household had the infection may suggest a large distribution of the parasite in the area.

The three infected cats did not have ticks at clinical examination, but since the cats lived in a rural area they may have had contact with ticks, including *Rhipicephalus sanguineus* and *Amblyomma* spp. The first species is the known vector of *H. canis* and *Amblyomma* ticks might be potential vectors in Brazil, as suggested by O'Dwyer et al. (2001).

The species of *Hepatozoon* that infects cats remains to be determined. In the first report, Patton (1908) described *H. felis*; however Wenyon (1926) considered the parasite in cats to be indistinguishable from *H. canis* in the dog, jackal and hyena. The gamont measurements found in this study were very similar to the measurements found by Alencar et al. (1997) for *Hepatozoon* of fox (*C. thous*) from Brazil ($9.1 \pm 0.54 \times 5.3 \pm 0.46 \mu\text{m}$), slightly smaller than the *H. canis* gamont measurements ($11.42 \times 5.39 \mu\text{m}$ and $45.88 \mu\text{m}^2$ of area) found by Waner et al. (1994) and larger than the *Hepatozoon* gamont measurements found by Lane and Kocan (1983) in bobcats ($11.0 \times 2.5 \mu\text{m}$). It is probable that the species from cat is *H. canis*, but genetic characterization must be performed to confirm this suspicion. Whether *Hepatozoon* in cats have an effect on skeletal muscles should be investigated. Other studies will be conducted to better understand hepatozoonosis in cats in Brazil.

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