

# *Cytauxzoon felis* in a stray cat in Iran

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**Abstract** Cytauxzoonosis is a tick-borne disease caused by *Cytauxzoon felis*, a hematozoan piroplasm of wild and domestic felids which, in most cases, causes severe clinical disease with a high rate of mortality; however, some cats can survive cytauxzoonosis and asymptomatic cats are also recorded. In this report, the observation of *C. felis* in the blood smear and serum of a stray cat in Iran during analysis is described.

**Keywords** *Cytauxzoon felis* · Cat · Iran

## Introduction

Cytauxzoonosis is a tick-borne disease caused by *Cytauxzoon felis*, a hematozoan piroplasm belonging to the family Theileriidae. *C. felis* life cycle is divided into two phases: sexual phase in a tick host and asexual phase in a vertebrate host. The life cycle in the vertebrate host includes an intraerythrocytic phase and tissue (schizogonous) phase. Large schizonts develop in macrophages or monocytes (especially of liver) during schizogony. The tissue phase is the main reason for this disease to be fatal (Kier and Greene 1998; Millán et al. 2007).

The bobcat (*Lynx rufus*) is considered the natural host of *C. felis* in North America. This pathogen can also infect

domestic cats, in which cytauxzoonosis is characterized as a highly acute fatal febrile disease (Kier and Greene 1998; Millán et al. 2007).

In series of studies in the USA, it has been shown that *Dermacentor variabilis* and *Amblyomma americanum* can transfer *C. felis* (Blouin et al. 1984; Shock et al. 2011).

The first report of *C. felis* among domestic cats was announced by Wagner (1976) from Missouri, USA. This disease was reported from the south-central and southeastern parts of the USA (Shock et al. 2011). *Cytauxzoon* spp. are increasingly reported among domestic and wild felids species all around the world. For instant, some cases of domestic cats and bobcats that were infected with *Cytauxzoon* spp. have been reported from Spain (Millán et al. 2007; Luaces et al. 2005). Also, in other countries, some cases have been reported such as infection in a domestic cat in France (Criado-Fornelio et al. 2009) and in a Mongolian Pallas' cat (*Otocolobus manul*) in Mangolia with similar intraerythrocytic piroplasms named *Cytauxzoon manul* (Ketz-Riley et al. 2003).

Cytauxzoonosis diagnosis is made by indentifying piroplasms within erythrocytes in the stained blood smears. These piroplasms may appear as round oval "Signet rings" (1–1.5 µm in diameter), bipolar, oval "safety pin" forms (1–2 µm in diameter), tetrad forms, or anaplasmod round dots (less than 0.5 µm in diameter). In serum analysis, hyperbilirubinemia, hyperglycemia, hypoalbuminemia, and hypokalemia also may be detected (Bruce and Klink 2003).

This report is a description of *C. felis* in a stray cat in Iran as the first report of this parasite among domestic cats in Asia.

## Case presentation

During a project for the determination of Tehran stray cats' parasitic fauna, a blood sample of one male stray cat from the second region (Sattar Khan Park) of Tehran was taken, and the sample was divided into two portions. One was emptied in a

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tube with anticoagulant substance and the other in a tube without anticoagulant substance. The blood smear was taken and the samples were transmitted to the parasitology laboratory of Shahmirzad School of Veterinary Medicine. In order to keep the tubes cold, they were transferred in an ice flask. The blood smear was fixed and stained by Giemsa. The serum was separated from the sample in a tube without anticoagulant substance and stored at  $-20^{\circ}\text{C}$  and finally sent to a veterinary laboratory of Tehran University for analysis.

## Results

Several small round, pin-shaped, ring-form, and anaplasmoid round dot-shaped *C. felis* (Figs. 1 and 2) and moderate decrease in red blood cells (anemia) were observed in the blood smear (Fig. 2a).

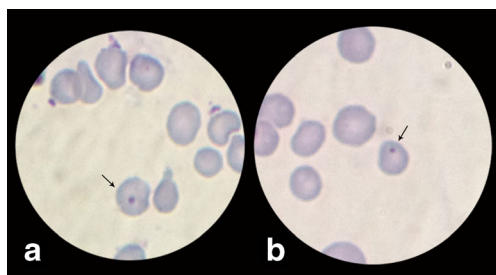
In leukocyte count, these changes were observed: the increase of lymphocytes (68 %) and the decrease of neutrophils (14 %). An increase of vacuolation and toxic changes of neutrophils were seen, which resulted in the increase of band cells (12 %). Monocytes (4 %), eosinophils (2 %), and basophils (0 %) were in the normal range.

In serum analysis, normal amounts of sugar, protein, urea, and bilirubin were recorded but the alanine aminotransferase (ALT)/alkaline phosphatase (ALP) concentration had increased.

The cat had anxious behavior during sample collection, so it was necessary to inject it with a tranquilizer.

## Discussion

In Iran, there are a lot of stray cats living in the streets and public parks. With respect to the life cycle of *Cytauxzoon* spp., cats with access to the outdoors (especially wooded areas) are at higher risk of coming into contact with infected ticks and being infected (Bruce and Klink 2003). Stray cats can move freely and can transfer the disease by moving the stuck ticks or infecting new ticks after blood sucking.



**Fig. 1** a, b Anaplasmoid dots of *C. felis* in red blood cells (RBCs) (black arrows). Stained by Giemsa,  $\times 200$

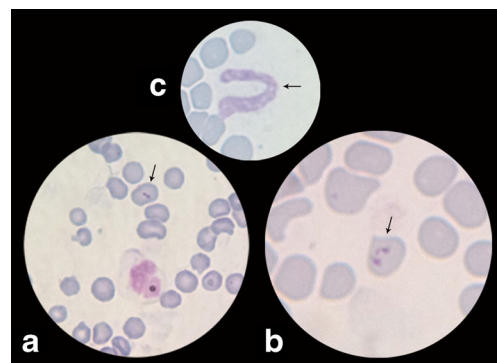
The most important disease phase that plays a critical role in the pathogenicity is the schizogonous cycle.

Exposure to the schizogonous phase in domestic cats can cause clinical disease and eventually death (Meinkoth and Kocan 2005). Schizonts were detected in the liver, spleen, lung, and lymph nodes. Schizonts in experimentally infected bobcats (*L. rufus*) were seen 11 days after exposure to infected *D. variabilis* (Blouin et al. 1987). Numerous schizonts were detected in laden macrophages of the heart, lung, liver, spleen, and kidney of *C. felis*-infected queen that had aborted her kittens and had shortly died after abortion (Weisman et al. 2007).

In this study, the infected cat could not be found when we went back to the park 2 weeks after the first sampling. Therefore, more study on this case could not be done.

In clinical chemistry, anemia, leukopenia with left shift, and toxic changes of neutrophils, thrombocytopenia, bilirubinuria, and hyperbilirubinemia can be found in serum analysis. Hypoalbuminemia, hyperglobulinemia, and hyperbilirubinemia are commonly detected in the final phases of the disease course (Franks et al. 1987; Meinkoth and Kocan 2005). Neutropenia and lymphocytosis were recorded in a mountain lion (*Puma concolor*) that had *Cytauxzoon*-like piroplasms in its blood sample (Soares et al. 2004). In cougars (*Puma concolor cougar*), in addition to the diagnosis of thrombocytopenia, the increase of serum bilirubin concentration, and the increase of ALT and aspartate aminotransferase (AST) were also recorded (Harvey et al. 2007). In this study, as described in the “Results” section, a moderate decrease in red blood cells (anemia), lymphocytosis, neutropenia with toxic changes, and increased ALT/ALP concentration were seen. Therefore, it seems that clinical chemistry findings are closely related to sampling time postinfection and the *C. felis* strain.

*D. variabilis* was recognized as a definitive host for domestic cats and wild felids in the USA and Brazil (Blouin et al. 1987; De La Fuente et al. 2008; Shock et al. 2011). In an



**Fig. 2** a Moderate decrease in red blood cells (anemia) and one pin-shaped *C. felis* in cat's RBCs (black arrow),  $\times 100$ . b One ring-form and one pin-shaped *C. felis* in RBCs (black arrow),  $\times 200$ . c Band cell with increasing vacuolation (black arrow),  $\times 200$ . Stained by Giemsa

experimental study in the USA, domestic cats were successfully infected with an *A. americanum* which had been infected by *C. felis* (Brown et al. 2009, Edwards et al. 2010).

Unfortunately, in Iran, there is no information about the ticks that potentially can infect cats.

Historically, disease caused by *C. felis* is considered fatal (near 100 % mortality rate); however, increasing reports of domestic cats that survive cytauxzoonosis and reports of asymptomatic cats suggest the existence of different parasite strains and pathogenicity (Brown et al. 2008). There are different polymerase chain reactions (PCRs) for the detection of *C. felis* gene such as 18S rRNA gene (Millán et al. 2007) and ribosomal internal transcribed spacer regions 1 and 2 (ITS1, ITS2). Eleven different sequences for ITS1 and ITS2 regions among infected domestic cats were found by Brown and his coworkers (2009).

This is the first report of *C. felis* infection among cats in, Iran but the precise molecular characterization of the strain and the tick vectors of this disease is still unknown, so it could not be claimed that the *Cytauxzoon* which was observed in this study is definitely similar to what was seen among domestic cats in the USA and Europe. It should be noted that this disease exists in Iran, and further studies have to be done to clarify the ambiguous aspects of this newly discovered disease.

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**Conflict of interest** No competing financial interests exist.

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