**Cytauxzoon felis** Infection in Domestic Cats, Yunnan Province, China, 2016

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We performed a molecular survey for *Cytauxzoon felis* infection in 311 domestic cats in Yunnan Province, China, in 2016 and found a prevalence of 21.5%. *C. felis* infection in domestic and wild cats in other provinces should be investigated to determine parasite prevalence and genetic diversity among cats throughout China.

*Cytauxzoonosis* is a tickborne hemoprotozoal disease of both domestic cats and wild felids caused mainly by *Cytauxzoon felis* protozoa (1,2). In the late 1900s, *C. felis* protozoa were reported exclusively in North America, particularly in the mid-Atlantic states of the United States (3), but in the early 2000s, this pathogen was reported in some countries of South America, and in Europe, several other *Cytauxzoon* species were identified (4). Cytauxzoonosis of domestic cats has long been considered contagious and deadly (2). However, as research progressed, the virulence of different *C. felis* isolates was found to be inconsistent; some cats were able to survive the infection and potentially serve as natural reservoirs (5).

The number of pet cats around the world is increasing, but the information about the prevalence of *C. felis* infection in domestic cats is limited worldwide. Because of the seriousness of feline cytauxzoonosis and its geographic expansion to more and more regions, informing veterinarians, pet owners, and the general public about this disease has become imperative. The objective of this study was to examine whether *C. felis* infection is present in domestic cats in China.

**The Study**

During November–December 2016, we collected whole blood from the femoral vein of 311 domestic cats (74 stray cats and 237 pet cats) in Yunnan Province in southwestern China using EDTA tubes. We stored these EDTA whole blood samples at –20°C and then performed genomic DNA extraction with the TIANamp Genomic DNA Kit (TianGen, http://www.tiangen.com) following the manufacturer’s protocol. To detect *C. felis* infection, we performed a PCR targeting the second internal transcribed spacer (ITS-2) of ribosomal DNA (6). We sequenced amplicons in both directions and compared these sequences with those of other relevant *C. felis* isolates available in GenBank. We analyzed differences in *C. felis* prevalence in domestic cats according to lifestyle, region, sex, and age using the χ² test in SPSS 22.0 standard version for Windows (IBM Corporation, https://www.ibm.com). We considered differences statistically significant when the p value obtained was <0.05.

In total, 67 (21.5%) of 311 examined domestic cats were positive for the *C. felis* protozoan. We sequenced these *C. felis*-positive PCR products and obtained 67 ITS-2 sequences; 4 representative sequences were deposited in GenBank (accession nos. MF966369–72). The 67 *C. felis* ITS-2 sequences shared 98.4%–100% similarity. These sequences had 95.6%–100% similarity with corresponding *C. felis* ITS-2 sequences available in GenBank.

The prevalence of *C. felis* protozoa in domestic cats in Yunnan Province was 21.5% (Table), lower than the prevalence in domestic cats in the United States (30.3%, 27/89) (7) but higher than that in Brazil (0.66%, 1/151) (8). The *C. felis* prevalence in stray cats (51.4%, 38/74) was significantly higher (p<0.001) than that in pet cats (12.2%, 29/237) (Table), probably because stray cats often live outdoors with poor sanitation, thus having high probability of contact with ticks. However, no significant difference in *C. felis* prevalence was found among domestic cats of different sexes or age groups.

Distinct *C. felis* genotypes of different virulences in domestic cats have been identified, and genetic diversity among *C. felis* populations has been studied by comparisons of 18S rRNA, ITS-1, and ITS-2 sequences (1). ITS-1 and ITS-2 rDNA are better genetic markers for assessing *C. felis* genotypic variability (9) because these sequences evolve faster than the 18S rRNA gene. A combination of ITS-1 and ITS-2 sequences has been used to identify the *C. felis* genotypes present in various domestic cats and wild felids (1).

*C. felis* protozoa are transmitted to domestic cats by ticks, such as *Amblyomma americanum* and *Dermacentor*...
variabilis (1). Raising pet cats indoors and preventing and treating ectoparasites of outdoor stray cats would help reduce risk for infection in C. felis protozoa–endemic areas. Some effective antitick insecticides can be used for preventing transmission of this parasite (10).

Conclusions

Our study revealed a high (21.5%) C. felis prevalence in domestic cats in Yunnan Province, China. Further studies are warranted to assess the prevalence of the C. felis protozoan in wild felids and domestic cats in other regions of China to estimate its geographic distribution and genetic diversity and to investigate its potential tick vectors.

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References

1. Wang JL, Li TT, Liu GH, Zhu XQ, Yao C. Two tales of Cytauxzoon felis infections in domestic cats. Clin Microbiol Rev. 2017;30:861–85. http://dx.doi.org/10.1128/CMR.00010-17
2. Sherrill MK, Cohn LA. Cytauxzoonosis: diagnosis and treatment of an emerging disease. J Feline Med Surg. 2015;17:940–8. http://dx.doi.org/10.1177/1098612115610681
3. Birkenheuer AJ, Le JA, Valenzasi AM, Tucker MD, Levy MG, Breitschwerdt EB. Cytauxzoon felis infection in cats in the mid-Atlantic states: 34 cases (1998–2004). J Am Vet Med Assoc. 2006;228:568–71. http://dx.doi.org/10.2460/javma.228.4.568
4. Carli E, Trotta M, Chinelli R, Drigo M, Singoli I, Tosolini P, et al. Cytauxzoon sp. infection in the first endemic focus described in domestic cats in Europe. Vet Parasitol. 2012;183:343–52. http://dx.doi.org/10.1016/j.vetpar.2011.07.025
5. Rizzi TE, Reichard MV, Cohn LA, Birkenheuer AJ, Taylor JD, Meinkoth JH. Prevalence of Cytauxzoon felis infection in healthy cats from enzootic areas in Arkansas, Missouri, and Oklahoma. Parasit Vectors. 2015;8:13. http://dx.doi.org/10.1186/s13071-014-0618-z
6. Brown HM, Latimer KS, Erikson LE, Cashwell ME, Britt JO, Peterson DS. Detection of persistent Cytauxzoon felis infection by polymerase chain reaction in three asymptomatic domestic cats. J Vet Diagn Invest. 2008;20:485–8. http://dx.doi.org/10.1016/j.jvdi.2008.06.001
7. Brown HM, Lockhart JM, Latimer KS, Peterson DS. Identification and genetic characterization of Cytauxzoon felis in asymptomatic domestic cats and bobcats. Vet Parasitol. 2010;172:311–6. http://dx.doi.org/10.1016/j.vetpar.2010.04.041
8. André MR, Herrera HM, de Jesus Fernandes S, de Sousa KCM, Goncalves LR, Domingos IH, et al. Tick-borne agents in domesticated and stray cats from the city of Campo Grande, state of Mato Grosso do Sul, midwestern Brazil.Ticks Tick Borne Dis. 2015;6:779–86. http://dx.doi.org/10.1016/j.tbbdis.2015.07.004
9. Shock BC, Birkenheuer AJ, Patton LL, Olfenbuttel C, Beringer J, Grove DM, et al. Variation in the ITS-1 and ITS-2 rRNA genomic regions of Cytauxzoon felis from bobcats and pumas in the eastern United States and comparison with sequences from domestic cats. Vet Parasitol. 2012;190:29–35. http://dx.doi.org/10.1016/j.vetpar.2012.06.010
10. Reichard MV, Thomas JE, Arther RG, Hostetler JA, Raitzel KL, Meinkoth JH, et al. Efficacy of an imidacloprid 10%/flumethrin 1.8% spot-on treatment for prevention of Cytauxzoon felis transmission to domestic cats. Am J Vet Res. 2013;112(Suppl 1): 11–20. http://dx.doi.org/10.1093/ajvr/amt099

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