Case Report: Atypical *Toxoplasma gondii* Strain from a Free-living Jaguar (*Panthera onca*) in French Guiana

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Abstract. Like domestic cats, wild felids are involved in the complete infective cycle of *Toxoplasma gondii* because they can host in their gastrointestinal tract sexually mature parasites and shed infective oocysts in their feces. We report, to our knowledge, the first isolation and molecular characterization of a *T. gondii* strain from the heart tissue of a free-living jaguar (*Panthera onca*) in French Guiana. Sequencing at six polymorphic markers indicated that the jaguar isolate had an atypical genotype, including an allele at TgM-A previously found only in isolates from South America, and an allele at GRA6, which was previously reported only in Californian sea otter isolates. These findings are consistent with the recent description of atypical *T. gondii* strains involved in severe toxoplasmoses in immunocompetent patients in French Guiana that seemed to be linked to a neotropical forest-based cycle involving wild cats and their prey.

Domestic cats are involved in the spread of *Toxoplasma gondii* infection in animals and humans worldwide. All species of felines, including wild ones, are likely to be definitive hosts because they are the only animals that can excrete the environmentally resistant oocysts of the parasite. In Europe or the United States, the domestic cycle of *T. gondii* involves cats and peridomestic and domestic animals such as pigs and sheep, and most (> 95%) cats and peridomestic and domestic animals such as pigs and sheep, and most (> 95%) domestic prey (mostly chickens, but also cattle and even dogs and cats) near remote human habitats. Thus, transmission from domestic animals to wild animals is possible. In the rainforest uninhabited zones, jaguars usually prey on animals weighing at least 15 kg such as tapirs (*Tapirus* spp.), peccaries (*Tayassu* spp.), and cervids, such as...
white-tailed deer (*Odocoileus virginanus*) and brocket deer (*Mazama* spp.). However, they may also consume smaller prey such as coatis (*Nasua narica*), raccoons (*Procyon* spp.), pacas (*Agouti paca*), armadillos (*Dasipus novemcinctus*), and even small felids, such as ocelot (*Leopardus pardalis*).

Recent studies have provided support for a wildlife toxoplasmosis cycle, with demonstration of a significant toxoplasmosis seroprevalence in non-carnivorous wild mammals (i.e., folivores, frugivores, and granivores) living in an uninhabited forest zone (Petit Saut, French Guiana) that are major game species. Terrestrial mammals such as deer, armadillos, pacas, and peccaries were significantly more exposed to *T. gondii* than other mammals, which is consistent with levels of oral exposure related to ground-dwelling behavior. However, to date, no *Toxoplasma* isolate was collected from wild fauna in the Amazonian rain forest. This first report of *Toxoplasma* isolation in a free-living jaguar is a further argument for the existence of a *T. gondii* wildlife cycle. Less than 20% of the population of French Guiana has contact with the wild environment in inland areas and the inhabitants of the coastal region may occasionally have contact with the forest during their work or leisure activities.

We have reported severe cases of acquired toxoplasmoses in immunocompetent human patients in French Guiana and in a Surinamese border village. These patients had a severe and non-specific infectious syndrome with no response to traditional antibiotics and antimalarial drugs, visceral involvement of the pulmonary and hepatic systems, toxoplasmic seroconversion with high levels of toxoplasma-specific IgG and IgM, and a favorable response after treatment. All patients reported forest-related activities such ingestion of surface water, consumption of undercooked game meat, and hunting.

*Toxoplasma* isolates collected from peripheral blood of these patients had an atypical genotype that was different from type I, II, or III isolates described in Europe or North America. The atypical allele in *GRA6* found in the jaguar isolate and in most of human isolates in French Guiana has been described to date, only in isolates from South America (French Guiana, Brazil, and Surinam) typed with the five microsatellite markers used in this study (French Biologic Resource Center for *Toxoplasma*, unpublished data). Moreover, a type X allele at *GRA6* has also been included for comparison of sequences at this marker. Black boxes indicate single nucleotide polymorphisms not shared by at least two archetypal sequences. Gray boxes indicate microsatellite sequences. * indicates deletion sites. Nucleotide sequence data are available on GenBank under the accession numbers AY572593 (BK, TUB2), AY572621 (BK, W35), AY572650 (BK, TGM-A), AY572714 (BK, B18), AY572751 (BK, B17), AF239283 (RH, GRA6), AY572581 (ME49, TUB2), AY572631 (ME49, W35), AY572661 (ME49, TGM-A), AY572710 (ME49, B18), AY572759 (ME49, B17), AF239285 (ME49, GRA6), AY572595 (NED, TUB2), AY572632 (NED, W35), AY572662 (NED, TGM-A), AY572726 (NED, B18), AY572760 (NED, B17), AF239286 (NED, GRA6), AY964058 (TYPE X, GRA6), DQ009075-79, and DQ187387 (GUY-2004-JAG1).
ter) from different geographic sites to obtain a better understanding of the wildlife cycle and clearly proves its existence. Moreover, broad sampling of isolates from human toxoplasmoses (congenital cases or reactivation in immunocompromised patients) and domestic asymptomatic animals living in urban or peri-urban areas should provide more information about the genetic diversity of T. gondii in French Guiana.

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REFERENCES