DISEASES OF WILD JAGUARS IN SOUTHEASTERN MEXICO

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Resumen

Los grandes felinos silvestres sirven como un indicador de cambios en los ecosistemas. Estudios recientes demuestran que las enfermedades infecciosas tienen efectos devastadores en sus poblaciones. La conversión del hábitat debido a actividades antropogénicas ha aumentado la incidencia de enfermedades en la fauna silvestre, por lo que es importante identificar las enfermedades que los afectan, así como las condiciones ecológicas asociadas con su severidad y dispersión. En este estudio se evaluó y contrastó la seroprevalencia de enfermedades virales y bacterianas, la presencia de parásitos, y algunos parámetros hematológicos del jaguar en la Reserva de la Biosfera Calakmul, Campeche, y el Ejido Caoba, Quintana Roo. Los dos sitios tienen influenza de actividades antropogénicas, que es más intensa en el ejido. La seroprevalencia de enfermedades transmitidas por animales domésticos (parvovirus canino/panleucopenia felina) en el fue de 8%, la de por vectores (gusano felino del corazón) 86.6% y la de reservorios silvestres (toxoplasmosis) de 55.5% en el Ejido Caoba. En contraste no se encontraron anticuerpos para estas enfermedades en la Reserva de Calakmul. Se encontraron anticuerpos contra *Burcella abortus* en el único macho de la Reserva analizado y en uno de 8 animales muestreados en el Ejido Caoba. No se encontraron anticuerpos contra el virus de inmunodeficiencia felina, coronavirus felino, *Chlamydia*, ni evidencias del antígeno de leucemia viral felina para ningún sitio. Los cambios de hábitat debido a las actividades humanas podrían ser la causa de las seroprevalencias mayores en el Ejido Caoba. Los parámetros hematológicos de los ejemplares capturados en la Reserva son más parecidos a los valores obtenidos en animales en cautiverio; en el Ejido Caoba, los valores difieren de los animales en cautiverio principalmente en la fórmula leucocitaria.

Palabras clave: *Brucella*, enfermedades en fauna silvestre, leucemia viral, moquillo, parvovirus, toxoplasmosis.

Abstract

Large felids are indicators of ecosystem changes. Recent studies show that infectious diseases have devastating effects in their populations. Furthermore, habitat conversion due to anthropogenic activities has increased incidence of wildlife diseases, therefore, besides ecological data, it is important to identify both, the diseases potentially important to large

carnivores, and the ecological conditions associated with their expansion and severity. The seroprevalence of viral, bacterial and parasitic diseases and some hematological parameters were evaluated in wild jaguars from two places of Southern Mexico; the Calakmul Biosphere Reserve and Ejido Caoba. In Ejido Caoba, the seroprevalence of diseases transmitted by domestic carnivores (canine parvovirus/feline panleukopenia) was 8 %, by vectors (feline heart worm) 86.6 %, and by wild reservoirs (Toxoplasma) 55.5 %, while no antibodies were found within the Reserve. Antibodies against Brucella abortus *was found in the only male tested in the Reserve, and from one of 8 jaguars in Ejido Caoba (12.5%). Antibodies against feline immunodeficiency virus, feline coronavirus,* Chlamydia *and feline leukemia were not found. Habitat changes due to the human activities could be responsible for the greater seroprevaence in Ejido Caoba. The hematological parameters of wild jaguars from the Reserve are more similar that the values of captive jaguars, in Ejido Caoba, these values are different from the values of captive jaguars, mainly in the leukocyte formula.*

Key words: Brucella*, viral leukemia viral, distemper, parvovirus, toxoplasmosis, wildlife diseases.*

Introduction

Carnivores are very sensitive to habitat disturbances; their decline and disappearance are indicators of changes in ecosystems (Coté and Sutherland, 1997; Crooks and Soulé, 1999; Estes, 1996; Gittleman *et al.*, 2000). Strict carnivores of a large size that live in isolated populations and disperse great distances are more likely to become extinct (Purvis *et al.*, 2001; Woodroffe, 2001). Recent declines in wild carnivore populations have shown that infectious diseases have devastating effects on their conservation (Murray *et al.*, 1999). Habitat conversion due to anthropogenic activities has enhanced the role of diseases as regulators of survival in carnivores (Deem *et al.*, 2001; Dobson and Foufopoulos, 2001; Funk *et al.*, 2001). As populations of domestic ungulates and carnivores increase, generalist pathogens are more likely to spread to less abundant populations of wild carnivores (Funk *et al.*, 2001; Holmes, 1996). Habitat reduction also causes a concentration of species and individuals in remnant areas. This increases the rate of transmission of infectious agents, negatively affects nutritional status and increases stress, which makes species more susceptible to diseases and other population pressures (Deem *et al.*, 2001; Patz *et al.*, 2000; Scott, 1988). The effect of pathogens can shift from compensatory to additive. Even if mortality is compensatory, the population may be affected if pathogens decrease the reproductive rate or change the age structure (Funk *et al.*, 2001). At the edge of protected areas and in corridors, diseases can be the key factor preventing a population from persisting and dispersing successfully to other areas (Simberlof and Cox, 1987; Simoneti, 1995).

To prevent declines in carnivore populations, it is important to identify the dis-

eases that affect them as well as the ecological conditions associated to their severity and spread (Murray *et al.*, 1999). Therefore, ecological data are not enough for a carnivore conservation project to be successful. Diseases and infectious agents of the target species and possible reservoirs of diseases must also be taken into account (Funk *et al.*, 2001). In the wild, large felids are susceptible to diseases that are common in domestic dogs and cats, such as canine distemper, canine parvovirus, feline panleukopenia (Roelke *et al.*, 1993), and feline leukemia (Appel *et al.*, 1994; Blythe *et al.*, 1983; Fix *et al.*, 1989; Jessup *et al.*, 1993; Kock *et al.*, 1998; Parish, 1999; Paul-Murphy *et al.*, 1994; Roelke-Parker *et al.*, 1996; Richard and Foreyt, 1992). Antibodies against feline immunodeficiency virus have been found, although there was no evidence of associated disease (Barret, 1999; Brown *et al.*, 1994; Jarret, 1999; Spencer *et al.*, 1992).

The jaguar, one of the most endangered carnivores in Mexico, is used as an indicator to determine priority areas for conservation and make decisions about the appropriate size of protected areas and where to establish corridors between them (Ceballos *et al.*, 2005). Besides information about home ranges and activity patterns, the health of these populations must be taken into account. In spite of the importance of diseases and the health status of populations for conservation, there is no information about the seroprevalence of infectious diseases in wild populations of jaguars in Mexico or normal blood values of wild populations. Therefore, the aim of this study was to assess the seroprevalence of diseases and determine blood values of wild jaguars in a protected area –Calakmul Biosphere Reserve– and a fragmented environment –Ejido Caoba.

Methods

Jaguars were captured in Calakmul Biosphere Reserve, in Campeche, and Ejido Caoba, in Quintana Roo, from 2002 to 2005 (see Ceballos *et al.*, 2002; Chávez, 2006). The animals were immobilized with a mixture of xylazine (0.7-1.3 mg/kg) and ketamine (7.6-11 mg/kg). On some occasions anesthesia was reversed with yohimbine (0.125 mg/kg). A complete physical examination was performed, and antibiotics and anthelmintics were administered when necessary. Ectoparasites were collected, and 10 ml of blood was collected from the tarsal or femoral vein. After placing 1 ml of blood in tubes with EDTA anticoagulant, the samples were sent to the laboratory to obtain the blood values. The remaining blood was centrifuged to obtain serum and stored at -20°C until it was tested.

Seroprevalence of diseases was determined with the following commercial tests, and following the manufacturer's instructions: feline heartworm (FHW Antibody Test,Witness ®), feline immunodeficiency virus and feline leukemia virus (Snap FIV/FeLV, IDEXX), canine distemper (CDV IMMUNOCOMB® IgG antibody test kit), canine parvovirus (CPV IMMUNOCOMB® IgG antibody test kit), feline coronavirus (FCoV-FIP IMMUNOCOMB® antibody test kit), Toxoplasma and Chlamydia (Feline Toxo

& Chlamydia IMMUNOCOMB® Ab test kit). Seroprevalence of Brucella was determined at the Center for Research and Advanced Studies in Animal Health (CIESA) of the Autonomous University of the State of Mexico (UAEM) with the card test. Student's t-test was used to assess the differences in blood values between the two sites and the differences in the mean number of ectoparasite larvae.

Results and discussion

Samples were taken from 23 jaguars –19 in Ejido Caoba (9 females and 10 males) and 4 in Calakmul Biosphere Reserve (3 males and 1 female)–. Five jaguars were recaptured. All the jaguars were in good physical condition; most of them had scars or parts of their ears missing from fights. Three jaguars had lost tissue in their face, with similar lesions to those caused by cutaneous leishmaniasis.

There were differences in the presence and seroprevalence of diseases transmitted by domestic animals between Calakmul Biosphere Reserve and Ejido Caoba (Figure 1, Table 1). Between 1 and 50 (X = 13.8) larvae of the fly *Dermatobia hominis* were taken from 15 jaguars (Figure 2). The mean number of *Dermatobia* larvae was higher in Ejido Caoba than in Calakmul (18.2 and 3.7 respectively; P= 0.0296). In Ejido Caoba, seroprevalence of canine parvovirus/feline panleukopenia was 8%, that

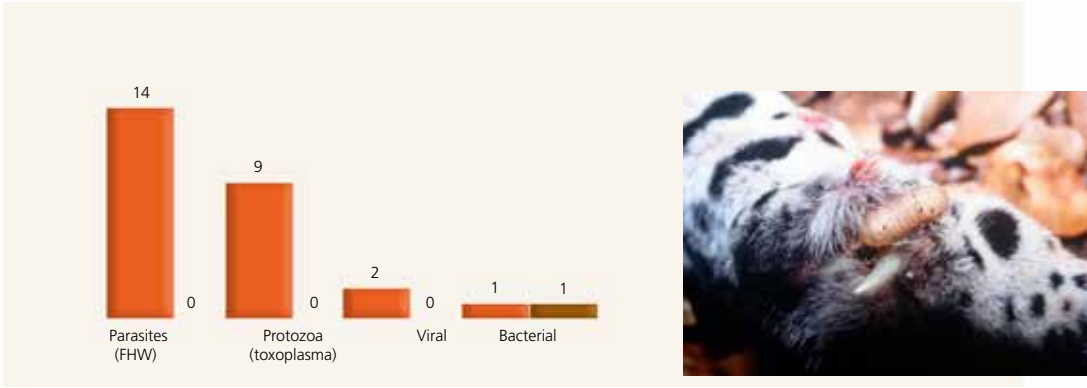

Figure 1 Number of jaguars with antibodies against viral, bacterial and parasitic diseases in Calakmul Biosphere Reserve and Ejido Caoba in Quintana Roo, Mexico.

Figure 2 (above). Larvae of the bot fly *Dermatobia hominis*.

Table 1. Seroprevalence of diseases in wild jaguars captured in Calakmul Biosphere Reserve and Ejido Caoba in Quintana Roo, Mexico

Diseases	Caoba	N	Calakmul	N
FeLv	0 %	16	0 %	3
FIV	0 %	16	0 %	3
FCoV	0 %	16	0 %	3
Chlamydia	0 %	16	0 %	3
Canine distemper	0 %	18	0 %	3
Canine parvovirus	8 %	18	0 %	3
Toxoplasma	55.5 %	16	0 %	3
FHW	86.6 %	16	0 %	3
Brucella abortus	12.5 %	8	100%	1

of vectors (i.e., feline heartworm) was 86.6% and that of toxoplasmosis was 55.5%. However, no antibodies to these diseases were found in the biosphere reserve (Table 1). Antibodies against *Brucella abortus* were found in the only male in the Reserve that was tested for the disease, and in one of 8 animals tested in Ejido Caoba. No antibodies against feline immunodeficiency virus, feline coronavirus or *Chlamydia* were found in either site, nor was any evidence of the feline leukemia virus antigen (Table 1). The mean blood values of wild jaguars captured in Calakmul Biosphere Reserve are more similar to mean values obtained in captive animals (Deem, 2002) than values of jaguars captured in Ejido Caoba (Table 2; Figures 3 - 4).

Table 2. Comparison of blood values (t-student) of wild jaguars of Calakmul Biosphere Reserve and Ejido Caoba in Quintana Roo, Mexico, with blood values of captive jaguars (Deem, 2002)

Blood Values	Caoba-Calakmul	Reference Caoba	Reference Calakmul
Hematocrit	0.312	0.0004	0.3768
Hemoglobin	0.165	0.5182	0.1421
MCHC	0.829	0	0.0023
MCV	-	0	-
MCH	-	0.2815	-
Platelet count	-	0.2017	-
RBC	-	0.3192	-
WBC	0.314	0.0002	0.2759
Neutrophils	0.264	0.0501	0.838
Lymphocytes	0.985	0.0044	0.1171
Eosinophils	-	0.0005	

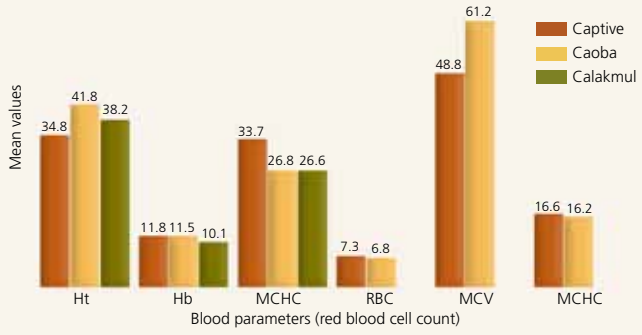

Figure 3. Mean values of blood parameters (red blood cell count) of captive and wild jaguars in southeastern Mexico. Data for captive jaguars were taken from Deem (2002).

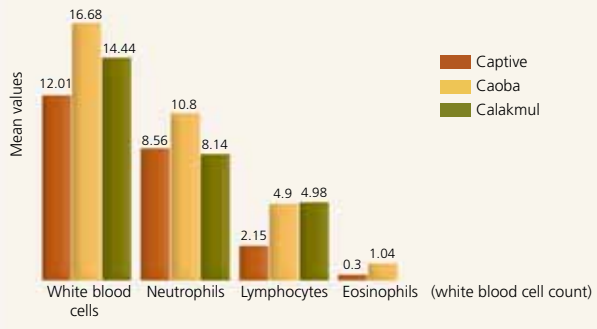

Figure 4. Mean values of blood parameters (white blood cell count) of captive and wild jaguars in southeastern Mexico. Data for captive jaguars were taken from Deem (2002).

Bloody feces were observed in one of the two males with antibodies against parvovirus/panleukopenia; this is the main characteristic of acute infection (Steinel *et al*, 2000). Although it is not known whether parvovirus/panleukopenia affects populations of wild felids, a high prevalence has been associated to a greater mortality in the offspring of other wild carnivores (Creel *et al*., 1997; Johnson *et al*., 1994; Mech and Goyal, 1995). The prevalence of these viruses in wild carnivores has been related to the presence and proximity of domestic cats and dogs, a large home range and long dispersal distances (Biek *et al*., 2002; Hofman-Lehmann *et al*., 1996; Riley *et al*., 2004). There is no information about the prevalence of these viruses in domestic carnivores of the region. Yet, if domestic dogs in Ejido Caoba were affected by an epizootic, it could have a negative impact on the jaguars, mainly through offspring mortality. In this area, it is common for dogs to be present in the home range of jaguars, alone or with hunters; dogs are occasionally predated by jaguars (M. Araiza, pers. obs.), which increases the risk of contagion. These viruses are shed in feces and are very resistant to high temperatures and droughts, so they remain infective for months (Gordon and Angrick, 1986; Steinel *et al*., 2001).

No antibodies against canine distemper were found, which shows either that jaguars die after being exposed to the virus or that they have never had contact with it (Table 1); the second scenario is dangerous because a distemper epizootic could cause a high mortality, as has happened in other populations of wild felids (Apel, 1987; Roelke-Parker *et al*., 1996). This scenario is more likely in areas with greater fragmentation and contact with dogs. Jaguars whose home range is on the boundary of Calakmul Biosphere Reserve and that have greater contact with human settlements have a greater risk of acquiring the virus. In the case of parvovirus/panleukopenia and distemper, direct contact between jaguars and dogs is not necessary, because prey species such as procyonids and mustelids are susceptible to the disease and can acquire it from dogs and transmit it to jaguars (Green, 1993; Parrish, 1999).

Like all vector-borne diseases, seroprevalence of antibodies against *Dirofilaria* (heartworm) depends of environmental factors that affect its reproduction, growth, survival, transport and the spread of the infectious agent. In other areas, the transmission of heartworm is seasonal (Watts *et al*., 2001). The minimum temperature at which vector mosquitoes survive is 14° C, and conditions are more favorable when mean temperatures are above 20° C (Vezzani *et al*., 2006). In the biosphere reserve and Ejido Caoba, mean annual temperature is favorable to the survival of *Dirofilaria* vectors (26° C). However, the presence of *Dirofilaria* is affected by the availability of breeding sites for its vectors. A high prevalence of heartworm and other diseases transmitted by vector mosquitoes has been associated to riparian areas, to the accumulation of water in areas with high rainfall, and droughts in tropical areas where people store water in open containers (Gortazar, 1994; Linthicum *et al*., 1988; Moore *et al*., 1978; Sheppard *et al*., 1969). Deforestation exposes water containers to more sunlight, which improves the conditions of breeding sites for vectors (Walsh

et al., 1993). In Ejido Caoba, human activities such as the changes in land use and a greater availability of stored water may be contributing to an increase in the vectors that transmit *Dirofilaria*. The high seroprevalence found in Ejido Caoba could become a public health problem, since *Dirofilaria* can be transmitted to humans and cause pulmonary nodules (Miyoshi *et al*., 2006; Narine *et al*., 1999; Rodrigues-Silva *et al*., 1995).

The difference in the seroprevalence of toxoplasma between Ejido Caoba and the Biosphere Reserve may also be due to changes in land use caused by human activities; this has been associated to a high prevalence of toxoplasma in other wild animal species (Anwar *et al*., 2006; Gaydos *et al*., 2007; Kikuchi *et al*., 2004; Roser-Degiorgis *et al*., 2006) and humans (Etheredge *et al*., 2004; Frenkel and Ruiz, 1981). Human constructions and activities compact the soil, creating favorable conditions for the survival of toxoplasma oocysts. Prevalence is also high in areas with a greater proportion of water bodies, which create a favorable microclimate for oocysts (Zarnke *et al*., 2001). It is very important to take preventive measures against the transmission of toxoplasma. In humans, it causes reproductive problems such as miscarriages, reduces psychomotor development (Flegr, 2007) and is associated to a greater number of cases of schizophrenia (Torrey *et al*., 2006). Water contaminated with feces of wild felids has been a source of transmission of toxoplasmosis epidemics in humans; domestic dogs act as mechanical vectors, by rolling in feces of wild or domestic felids (Aramini *et al*., 1999; de Moura *et al*., 2006; Frenkel *et al*., 1995; Lindsay *et al*., 1997).

As regards the antibodies against *Brucella abortus* found in one jaguar of the reserve and one in Ejido Caoba, there are no records of its prevalence in wild animals in these areas. Yet, the disease may be present in cattle and goats in the region. The higher white blood cell values of jaguars in Ejido Caoba suggests that they may be suffering from chronic or acute inflammatory processes, inflammatory conditions due to antigenic stimulation, or parasitic infestations (Rebar *et al*., 2005). Although an increase in these values can be caused by stress or the handling of the animals, the method used to capture the jaguars and handle the samples was the same in the biosphere reserve and Ejido Caoba. Therefore, the results may reflect the health status of the population.

Finally, this study highlights the importance of assessing the health status and the prevalence of diseases in wildlife. It is therefore necessary to continue to study the jaguar population in the region but also broaden the study to other species to understand the mechanisms of transmission and the role of domestic animals in the process.