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ORIGINAL ARTICLE /ARTÍCULO ORIGINAL

GASTROINTESTINAL PARASITES IN LARGE FELINES AT THE MOROLEÓN ZOO, GREEN AREAS OF GUANAJUATO, MEXICO

PARÁSITOS GASTROINTESTINALES EN GRANDES FELINOS DEL PARQUE ZOOLÓGICO DE MOROLEÓN ÁREAS VERDES DE GUANAJUATO, MÉXICO

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ABSTRACT

Zoos and wildlife conservation centers play a fundamental role in protecting a wide range of species. Therefore, monitoring the health of animals under human care is essential to ensure their welfare and

support conservation efforts. In this study, gastrointestinal parasites were identified in captive felids housed at the Moroleón Áreas Verdes Zoo Park in Guanajuato, Mexico. In June 2025, a total of 32 fecal samples were collected from 16 felids housed in seven enclosures, including *Panthera leo* (Linnaeus, 1758), *Panthera tigris* (Linnaeus, 1758), *Panthera leo krugeri* (Roberts, 1929), *Panthera onca* (Linnaeus, 1758), *Puma concolor* (Linnaeus, 1771), and *Lynx rufus* (Schreber, 1777). The samples were examined using conventional coproparasitological techniques to detect and identify eggs, larvae, oocysts, and other parasitic stages. Structures morphologically consistent with cestode and ascarid eggs were detected. These findings provide useful information on the gastrointestinal parasites present in captive felids and highlight the importance of implementing periodic parasitological surveillance programs to characterize the epidemiology of parasitic infections in these species in Mexico. By promoting animal health and welfare through this type of monitoring, the Moroleón Áreas Verdes Zoo Park demonstrates its commitment to generating information on the health status of the exotic and wild species housed at the facility.

Keywords: ascarids – captive felids – Cestodes – coproparasitology – gastrointestinal parasites – Mexico – zoo

RESUMEN

Los zoológicos y centros de conservación desempeñan un papel fundamental en la protección de diversas especies, por lo que es importante monitorear la salud de los animales bajo cuidado humano para garantizar su bienestar y su conservación. En este estudio se identificaron parásitos gastrointestinales en grandes felinos en cautiverio, en el Parque Zoológico de Moroleón Áreas Verdes de Guanajuato, México. En junio de 2025, se recolectaron 32 muestras fecales de 16 felinos alojados en siete recintos, correspondientes a [*Panthera leo* (Linnaeus, 1758), *Panthera tigris* (Linnaeus, 1758), *Panthera leo krugeri* (Roberts, 1929), *Panthera onca* (Linnaeus, 1758), *Puma concolor* (Linnaeus, 1771) y *Lynx rufus* (Schreber, 1777)]. Las muestras se analizaron mediante técnicas coproparasitoscópicas convencionales para detectar e identificar huevos, larvas, ooquistes y otras formas parasitarias. Se encontraron

estructuras compatibles con huevos de parásitos de cestodos y sacáridos. Estos resultados ofrecen información útil sobre los parásitos presentes en grandes felinos en cautiverio y resaltan la importancia de implementar programas periódicos de vigilancia parasitológica para establecer la epidemiología parasitaria de estas especies en México. Al garantizar el bienestar animal en los centros de conservación, el Parque Zoológico de Moroleón Áreas Verdes demuestra su compromiso e interés en generar información sobre la salud de estas especies exóticas y salvajes que se encuentran en sus instalaciones.
Palabras clave: ascáridos – Cestodos – coproparasitología – felinos en cautiverio – México – parásitos gastrointestinales – zoológico

INTRODUCTION

The relationship between humans and wild animals in captivity has undergone significant evolution, reflecting changes in social, ethical, and scientific values. Initially, zoos were established primarily for entertainment purposes and as symbols of social status. However, with scientific progress, society now recognizes these spaces as conservation centers whose main objectives are the protection of threatened species, environmental education, scientific research, and recreation (Beer *et al*., 2023).

Within this context, large felids occupy a prominent place in zoological parks, as they represent one of the groups most visited and valued by the public (Carr, 2016). This has driven the implementation of strategies aimed at promoting their welfare, including environmental and sensory enrichment (Mazzuca *et al*., 2023). However, ensuring the welfare of these species is not limited to behavioral management but also requires active monitoring of their health status. Among the main threats to captive felids are gastrointestinal parasitic diseases, which are often asymptomatic but may be associated with high morbidity. Therefore, their timely detection is essential for establishing appropriate clinical and epidemiological management (Panayotova-Pencheva, 2013; Kvapil *et al*., 2017; Sangpeng *et al*., 2023).

In this context, infectious and parasitic diseases in wildlife are of particular interest due to their direct and indirect effects on animal populations, their epidemiological relevance, and their health implications (Kołodziej-Sobocińska, 2019; Salvarani *et al*., 2025).

Parasites can generally cause severe damage, with the severity and risk varying according to several factors, including the parasite species, its location within the host, and the host's living conditions (Kołodziej-Sobocińska, 2019). Likewise, certain conditions associated with animals maintained under human care, such as the accumulation of infective stages in enclosures, frequent contact with contaminated surfaces, animal density, and stress, may favor the transmission and persistence of some parasitic infections (Dhakal *et al*., 2022). Chronic stress associated with captivity may also alter the immune response and increase the susceptibility of some animals to infections, although its effect varies among species and management conditions (Fischer & Romero, 2019).

Several studies have reported parasitic infections in felids under human care. In zoos in Thailand, an epidemiological surveillance study recorded an overall prevalence of intestinal parasites of 23.7% in captive felids, with lions [*Panthera leo* (Linnaeus, 1758)] being the most affected group, reaching a positivity rate of up to 68.75% (Hongsrichan *et al*., 2025). Similarly, in African lions kept in a park in Zimbabwe, *Toxascaris leonina* (von Linstow, 1902) was detected in 43.3% of individuals and *Toxocara cati* (Schrank, 1788) in 40% (Mukarati *et al*., 2013). In Latin America, a study conducted in Brazil reported an ascarid prevalence of 51.04% in captive animals (Da Silva *et al*., 2025), whereas in Mexico, an evaluation of captive carnivorous mammals showed a prevalence of 46.15%, with *Toxascaris* sp. being the most frequent genus (Beltrán-León *et al*., 2022). These findings confirm that gastrointestinal parasitic infections are common and widely distributed in zoological collections across different regions of the world. Moreover, because many of these parasites have a high capacity for direct and indirect transmission, they may cause environmental contamination within enclosures and affect other species (Quintero-Cusguen *et al*., 2021).

Despite their public health and zoonotic relevance, few studies have focused on evaluating the prevalence of these infections. A previous study conducted in Morelia, Michoacán, assessed the presence of gastrointestinal parasites using coproparasitological analyses and flotation techniques (García-Borja,

2016). However, in the state of Guanajuato, information on the epidemiology of parasitic diseases in captive large felids remains scarce, representing a knowledge gap for conservation and animal health management in zoological institutions.

This lack of data highlights the need to implement periodic parasitological surveillance programs to characterize the epidemiology of these infections, prevent their transmission, and guide control strategies. Therefore, the present study aimed to identify the gastrointestinal parasites present in large felids under human care at the Moroleón Áreas Verdes Zoological Park, Guanajuato, using conventional coproparasitological techniques, in order to generate epidemiological information useful for health surveillance, animal welfare, and the conservation of these species in Mexico.

MATERIALS AND METHODS

Study area

The study was conducted at the Moroleón Áreas Verdes Zoological Park, located on the Moroleón–Piñícuaro highway, in the municipality of Moroleón, Guanajuato, Mexico (20°07′52.1″ N, 101°11′02.0″ W). This center operates as a facility for the care and protection of wildlife, where animals receive food, veterinary care, and specialized monitoring.

The work carried out at the zoological park contributes to conservation by allowing the evaluation of the potential reintegration of some individuals into their natural habitat. When this is not feasible, the animals are transferred to other suitable facilities where they can continue to receive proper housing, management, and specialized care.

Animals and study design

A descriptive cross-sectional study was conducted involving 16 large felids under human care, housed in seven enclosures within the park: enclosure 1, four lions [*Panthera leo* (Linnaeus, 1758)];

enclosure 2, one white tiger [*Panthera tigris* (Linnaeus, 1758)]; enclosure 3, three white lions [*Panthera leo krugeri* (Roberts, 1929)]; enclosure 4, three Bengal tigers [*Panthera tigris tigris* (Linnaeus, 1758)]; enclosure 5, two jaguars [(*Panthera onca* (Linnaeus, 1758)]; enclosure 6, two pumas [*Puma concolor* (Linnaeus, 1771)]; and enclosure 7, one bobcat [*Lynx rufus* (Schreber, 1777)]. The spatial distribution of individuals by enclosure is shown in Figure 1.

Sample collection

In June 2025, a total of 32 fresh fecal samples were collected from 16 large felids under human care, with two samples obtained per individual. Samples were collected directly from the substrate in each enclosure by carefully taking the upper portion of the fecal material to minimize contamination with soil or other debris. Approximately 50 g of feces were collected from each sample and placed in airtight glass containers, which were properly labeled with the individual and enclosure identification.

The samples were then transported to the Veterinary Medicine and Animal Science facilities of the Universidad Interserrana del Estado de Puebla, Ahuacatlán (UIEPA), maintaining the cold chain until processing. The general study procedure included a field phase for sample collection, a laboratory phase for the processing and identification of parasites, and a data analysis phase for recording, analyzing, and interpreting the information. This procedure is summarized in the flowchart shown in Figure 2.

Processing and coproparasitological techniques

Each sample was processed using three conventional coproparasitological techniques: direct smear, flotation with saturated sodium chloride (NaCl) solution, and sedimentation, following the general procedures described by Bowman (2021) and Ibarra-Velarde *et al*. (2023). The preparations were examined under a light microscope using 10× and 40× objectives to detect and identify different parasitic forms, including eggs, larvae, oocysts, and other structures. The combined use of the three

techniques allowed their performance to be compared in terms of the recovery and preservation of parasitic structures (Ibarra-Velarde *et al*., 2023).

Parasite identification

The identification of parasitic forms was based on their morphological and morphometric characteristics, including shape, size, color, and features of the outer covering or membranes, and by comparison with reference keys and descriptions (Bowman, 2021). Findings were recorded at the genus or family level, depending on the taxonomic resolution achieved through microscopic observation. Given the zoonotic potential of several of these parasitic infections, the presence of any structure compatible with a parasite of public health importance was considered sufficient to recommend the implementation of antiparasitic control strategies.

Data analysis

The data were analyzed using descriptive statistics. A sample was considered positive when at least one parasitic form was observed. Prevalence was calculated as the number of positive individuals or enclosures divided by the total number examined and expressed as a percentage. Results were organized by enclosure and species and are presented in tables and figures.

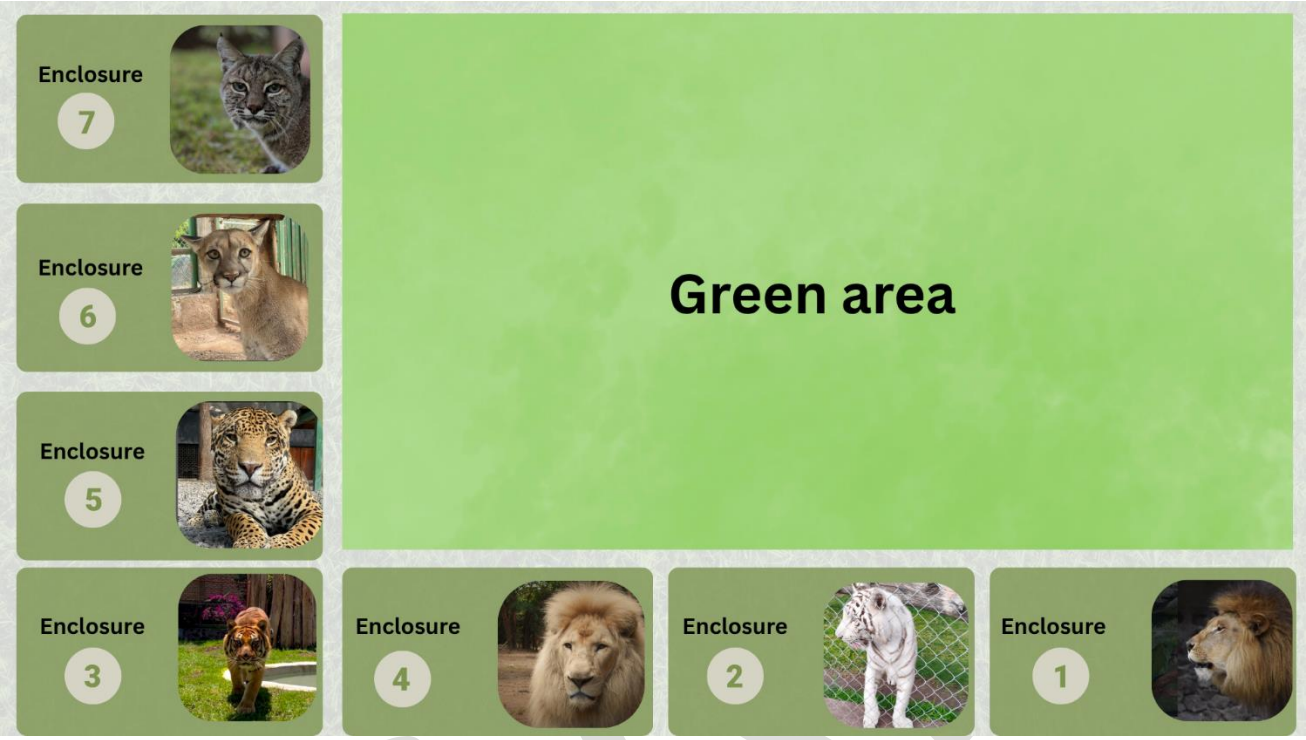

Figure 1. Spatial distribution of the large felids included in the coproparasitological study conducted in June 2025 at the Moroleón Áreas Verdes Zoological Park, Guanajuato, Mexico. The animals were housed in seven enclosures arranged around a common central area, which included resting and environmental enrichment zones.

Figure 2. Flow diagram of the activities performed during the coproparasitological study of large felids under human care. The methodology included three stages: 1) a field phase, corresponding to fecal sample collection; 2) a laboratory phase, focused on the processing and identification of parasites through microscopic analyses; and 3) a data analysis phase, aimed at recording, analyzing, and interpreting the generated information.

Ethical considerations

The study was conducted through the non-invasive collection of fecal samples from felids kept in captivity at the Moroleón Áreas Verdes Zoological Park. No capture, restraint, sedation, direct handling, or experimental procedures were performed on the animals. Sample collection was carried out with authorization and under the supervision of the personnel responsible for the zoological center, following its internal protocols for animal management, biosecurity, and welfare. Due to the non-invasive nature of the sampling procedure, the study did not alter the animals' routine, feeding, or housing conditions.

RESULTS

The analyses showed differences among the three coproparasitological techniques used. In the direct smear, ascarid and cestode eggs were identified. Using the flotation technique, abundant ascarid and cestode eggs were observed; however, these structures collapsed within a few minutes of observation. In contrast, the sedimentation technique allowed the observation of abundant cestode eggs, which did not collapse during microscopic examination.

Of the 32 fecal samples analyzed, only samples from enclosures 1, 2, and 3 were positive for intestinal parasite eggs. These enclosures corresponded to African lions, one white tiger, and white lions, respectively (Table 1). Coproparasitological analysis revealed the presence of two groups of gastrointestinal parasites: cestodes of the order Diphyllobothriidea and nematodes of the family Toxocaridae.

Table 1. Gastrointestinal parasitic forms identified in large felids from the Moroleón Áreas Verdes Zoological Park, Guanajuato, Mexico, according to enclosure, June 2025.

Enclosure	Species	Identified parasites
1	African lion (*Panthera leo*)	Cestodes (Diphyllobothriidae) and nematodes (Toxocaridae)
2	White tiger (*Panthera tigris*)	Nematodes (Toxocaridae)
3	White lion (*Panthera leo krugeri*)	Nematodes (Toxocaridae)
4	Bengal tiger (*Panthera tigris*)	Negative
5	Jaguar (*Panthera onca*)	Negative
6	Puma (*Puma concolor*)	Negative
7	Bobcat (*Lynx rufus*)	Negative

DISCUSSION

The coproparasitological analysis revealed the presence of cestodes and ascarids in fecal samples from African lions housed in enclosure 1, ascarids in the tiger from enclosure 2, and ascarids in the lions from enclosure 3. According to these findings, the gastrointestinal parasites affecting the felids at the Moroleón Áreas Verdes Zoological Park corresponded mainly to ascarids and cestodes. These results provide relevant epidemiological information on intestinal parasitic infections in large felids from the state of Guanajuato.

The identification of these parasitic groups is consistent with previous studies conducted in other regions of the world (Cañar-Romero & Lojano-Carmona, 2018), suggesting a broad and persistent distribution of these parasites among exotic felids and other wild animals kept under human care (Eom *et al*., 2019; Morales *et al*., 2022; Gómez-Ruiz & Lenis, 2025). Similar findings have been reported in studies describing gastrointestinal parasites belonging to the same taxonomic groups.

The detection of ascarids is particularly relevant because these nematodes have a high capacity for direct and indirect transmission, either through the ingestion of paratenic or non-paratenic hosts (Quintero-Cusguen *et al*., 2021) or through environmental contamination within enclosures. This finding is consistent with studies conducted in the state of Mato Grosso do Sul, Brazil, between 2022 and 2024,

where ascarid prevalences of 51.04% were reported in captive animals, including mammals, birds, and reptiles, and 23% in wild animals, including mammals and reptiles, under human management conditions (Da Silva *et al*., 2025). Their frequent occurrence may be related to the environmental resistance of their eggs and to management practices that do not eliminate sources of infection.

On the other hand, the detection of cestodes is significant because most of these parasites require intermediate hosts to reach their definitive hosts (Bowman, 2021). This raises important epidemiological questions regarding the possible transmission route: which organisms may have acted as intermediate hosts and allowed the parasite to reach the lions? Could wild fauna have entered the zoological park and participated in the parasite's life cycle? Alternatively, could this parasitic infection have been acquired through the transfer or exchange of animals?

Based on its morphological characteristics, the cestode strobila recovered in this study was considered compatible with *Spirometra* spp. (Kuchta *et al*., 2024). This finding is relevant because it represents a potentially novel record of *Spirometra* spp. in lions (*P. leo*) in Mexico, although molecular confirmation is required.

However, molecular diagnostic techniques are necessary to confirm this identification. Although cases of sparganosis caused by *Spirometra* had previously been documented in other hosts in Mexico, such as the oncilla [(*Leopardus tigrinus* (Schreber, 1775)] in 1933, as well as in domestic dogs and humans in subsequent decades (Chavarría, 1939; Landero *et al*., 1991), its identification in *P. leo* represents a finding that expands the known host spectrum of this parasitic genus in Mexico.

This is particularly relevant from a public health perspective because of the zoonotic potential of sparganosis, especially in contexts where contact between humans and felids may occur frequently (Salazar-Grosskelwing *et al*., 2024).

The combined use of macroscopic and microscopic techniques, including flotation and sedimentation, allowed the detection of both eggs and adult parasitic structures. This confirms the usefulness of integrated diagnostic approaches, even in the absence of visible clinical signs. These findings emphasize the importance of continuing to investigate the parasitic forms affecting large felids in Mexico (Cascón *et al*., 2017).

The findings of this study not only document the presence of intestinal parasites in captive felids in Mexico, but also open new lines of research on the epidemiology of these parasites in wildlife under human care. The identification of gastrointestinal parasites in lions, in particular, should be considered an important finding from both conservation and public health perspectives.

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