CARDIOPULMONARY CO-INFECTION BY STRONGYLOIDEA IN *Puma yagouaroundi* (CARNIVORA: FELIDAE) IN THE MUNICIPALITY OF CARLÓPOLIS – PR

CO-INFECÇÃO CARDIOPULMONAR POR STRONGYLOIDEA EM Puma yagouaroundi *(CARNIVORA: FELIDAE) NO MUNICÍPIO DE CARLÓPOLIS - PR*

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ABSTRACT

This study investigated Strongyloidea co-infection in a jaguarundi (*Puma yagouaroundi*) that was hit by a car in Carlópolis, PR. The objective was to examine fecal and cardiopulmonary samples to identify helminths. The hypotheses were: I) Parasitism in carnivores naturally occurs in wild environments; II) Predation favors cardiopulmonary co-infections; III) The passage of helminths through the lungs causes histological inflammation. Hoffman's sedimentation technique and flotation with hypersaturated NaCl solution were used for fecal analysis. In the lungs, the lower airways were scraped, sieved, and analyzed; lung fragments were macerated and left to sediment, while others were fixed in 10% formaldehyde for histopathological examination. The results revealed six helminths in the lungs: *Oslerus* sp., a pair of *Angiostrongylus* sp., and three *Aelurostrongylus abstrusus*, causing severe parasitic pneumonia. The study highlighted the relationship between these helminths and intermediate hosts, such as gastropods, as well as the role of domestic cats in maintaining these parasites in wildlife. Although based on a single case, the study concludes that integrated management measures are essential to mitigate these infections and promote the conservation of wild felines.
KEYWORDS: Concomitant infections, Metastrongyloidea, Nematoda, Paraná.

RESUMO

Este estudo investigou a coinfecção por *Strongyloidea* em um jaguarundi (*Puma yagouaroundi*) atropelado em Carlópolis, PR. O objetivo foi examinar amostras fecais e cardiopulmonares para identificar helmintos. As hipóteses testadas foram: I) O parasitismo em carnívoros ocorre naturalmente em ambientes silvestres; II) A predação favorece coinfecções cardiopulmonares; III) A passagem de helmintos pelos pulmões causa inflamação histológica. Utilizaram-se as técnicas de sedimentação de Hoffman e flotação com solução de NaCl hipersaturada para a análise fecal. Nos pulmões, as vias aéreas inferiores foram raspadas, peneiradas e analisadas; fragmentos pulmonares foram macerados e deixados em sedimentação,

enquanto outros foram fixados em formaldeído a 10% para exame histopatológico. Os resultados revelaram seis helmintos nos pulmões: *Oslerus* sp., um par de *Angiostrongylus* sp. e três *Aelurostrongylus abstrusus*, causando pneumonia parasitária grave. O estudo destacou a relação entre esses helmintos e hospedeiros intermediários, como gastrópodes, bem como o papel dos gatos domésticos na manutenção desses parasitas na fauna silvestre. Embora baseado em um único caso, o estudo conclui que medidas de manejo integrado são essenciais para mitigar essas infecções e promover a conservação de felinos silvestres.
PALAVRAS- CHAVE: Infecções concomitantes, Metastrongyloidea, Nematoda, Paraná.

INTRODUCTION

Strongyloidea is a superfamily of the phylum Nematoda containing lung and blood vessel parasites of mammals, occurring in several orders, including Carnivora[1]. The species *Aelurostrongylus abstrusus* (Railliet, 1898), and the genera *Angiostrongylus* Kamensky, 1905 (Angiostrongylidae) and *Oslerus* Hall, 1921 (Filaroididae) have already been described in domestic and wild felids[2,3]. These helminths have an indirect life cycle with gastropods predominantly as intermediate hosts[2-4]. Small rodents, amphibians, reptiles and birds also participate in transmission as paratenic hosts[4,5,6]. These intermediate and paratenic hosts are preyed upon by both wild and domestic cats, promoting the maintenance of the parasites in both environments.

Domestic cats with hunting behavior have a diet similar to that of the *Puma yagouaroundi* (Geoffroy, 1803), which includes small and medium-sized mammals (terrestrial and arboreal), birds, snakes, lizards and amphibians[7,8].

Due to their predatory behavior, wild animals and homeless cats are more predisposed to parasitism and are more likely to develop coinfections. Thus, mixed infections with bronchopulmonary parasites can reduce the organ's capacity and predispose animals to secondary infections[9], and the intensity of the parasitic infection can cause serious damage to the respiratory system and, in more severe cases, lead to the animals' death[10,11].

The location of the adult parasites in the host's lungs differs between species. *Aelurostrongylus abstrusus* are found in pulmonary arteries and their branches,

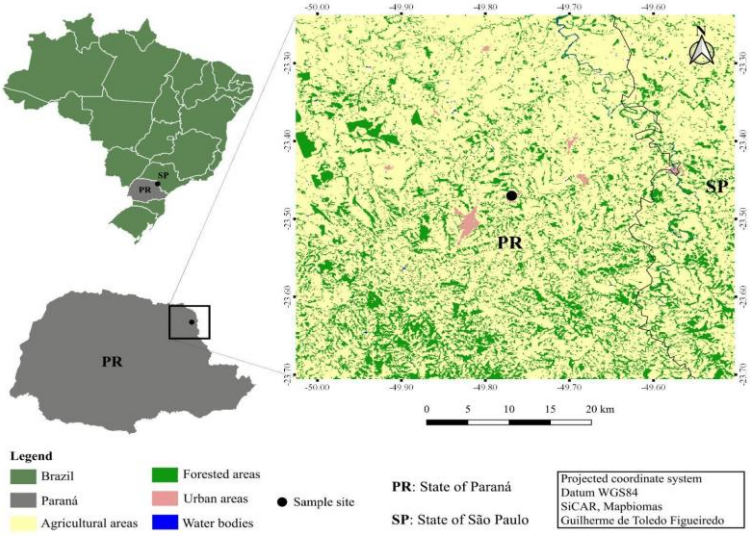
alveoli, alveolar ducts, bronchioles and lung parenchyma. Meanwhile, *Angiostrongylus* inhabits the pulmonary vessels and heart, causing granulomatous pneumonia, edema, alveolar emphysema and hemorrhages in the parenchyma. Parasites of the genus *Oslerus* are found in cysts near the bronchi[8,12].

In this context, in addition to the pathogenesis of cardiopulmonary infections caused by helminths, parasitological research on wild cats can provide information on the distribution of parasite species and their hosts, as well as the habits of these carnivores and the epidemiology of various diseases. The aim of this paper is to describe the occurrence of cardiopulmonary helminths in a Moor Cat (*Puma yagouaroundi*) in the north of the state of Paraná, southern Brazil.

METHODOLOGY

An adult male *Puma yagouaroundi* specimen was found dead as a result of a roadkill event on the PR-218 highway, in the municipality of Carlópolis, northern Paraná State, southern Brazil (23°25′S; 49°39′W). The site is located near remnants of Atlantic Forest, within a landscape mosaic of secondary forest fragments and rural areas (Figure 1).

Figure 1. The black dot is a location that was found in *Puma yagouaroundi* in the city of Carlópolis - PR.



The carcass was transported to the Zoology and Parasitology Laboratory of the Universidade Estadual do Norte do Paraná (UENP, CCHE–CJ) in September 2017, under SISBIO Authorization No. 57685-1 for scientific activities, where it was stored frozen until taxidermy. Afterward, the internal organs were used for necropsy and parasitological examinations.

Copro parasitological tests were carried out to identify parasitic structures such as helminth larvae and eggs, and protozoan cysts and oocysts. Fecal samples were examined using the sedimentation method and flotation in saturated sodium chloride solution. After macroscopic examination of the lungs, the lower airways were opened and their contents scraped and sieved through 600 µm, 425 µm and 150 µm sieves[13] to separate the helminths which were prepared for identification.

The helminths were fixed by soaking them in AFA for 48 hours[14]. After fixation, the specimens were clarified using Amann's lactophenol and mounted between slide and coverslip in Canada balsam for observation under an optical microscope[15].

The helminths found were identified according to Mönig[16] and Yamaguti[17]. Small lung fragments segmented with scissors were macerated by gradually adding water, then passed through double gauze, and the liquid content was left in a sedimentation cup. After six hours, the sediment was collected and observed under an optical microscope[18].

The parasitic forms were photographed and measured using an Opton optical microscope coupled to a Tucsen camera and the images captured using TCapture 3.9 software.

Lung fragments were soaked in 10% formaldehyde[2] and sent for histopathological examination at the Animal Pathology Laboratory of the State University of Londrina. All necropsy and histopathological procedures were carried out in accordance with Brazilian ethical and legal standards for research involving wild fauna.

RESULTS

Coprological examinations identified eggs of *Toxocara canis*, *Ancylostoma* sp**.**, *Physaloptera* sp., and *Spirometra* sp., while *Strongyloidea larvae* were observed both in the feces and in the sedimented lung macerate, as shown in Figure 2. The presence of larvae in this location is explained by the fact that cardiopulmonary helminths lay their eggs in lung tissue and air spaces, or their eggs reach the lungs via the bloodstream. They then develop into first-stage larvae (L1), ascend the respiratory tract, are swallowed, and eliminated through the host's feces[4,10].

Figure 2. Tail of a Strongyloidea larva observed in lung macerate (100×).

In the feline's lung examination, six adult specimens were found: one female *Oslerus* sp. (Figure 3), a pair of *Angiostrongylus* sp. (Figure 4), and three *Aelurostrongylus abstrusus* specimens, one female and two males (Figure 5). These parasites are commonly found in the lung parenchyma of both wild and domestic cats[2,9]. They have also been described in small pulmonary vessels, alveoli, terminal bronchioles, and alveolar ducts[5].

Figure 3. Tail of *Oslerus* sp. found in *Puma yagouaroundi* in North of Paraná (10X).

Figure 4. Tail of *Angiostrongylus* sp. (A: male B: female) found in *Puma yagouaroundi* in North of Paraná (40X).

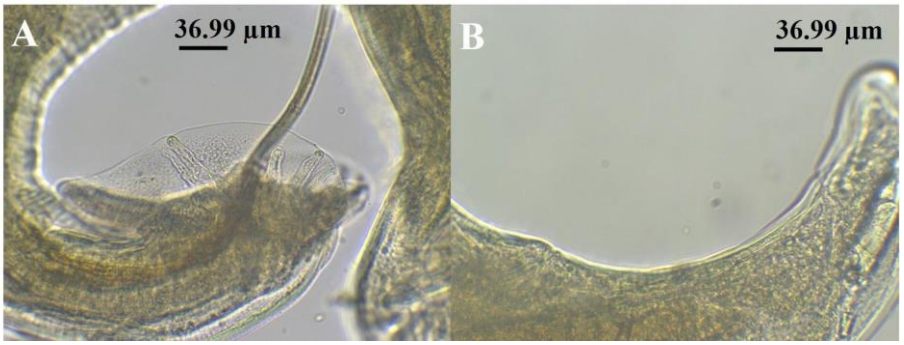
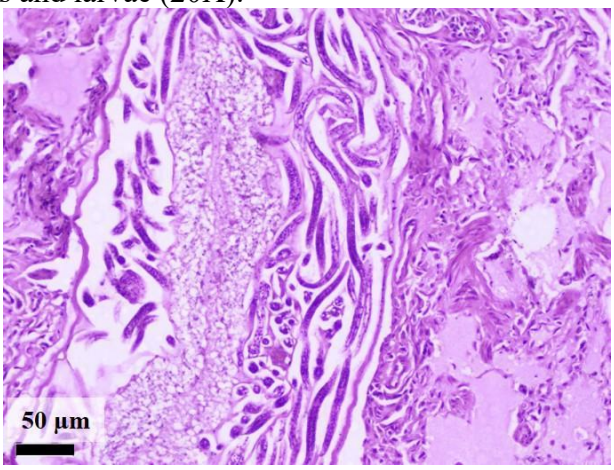


Figure 5. Tail of male *Aelurostrongylus abstrusus* found in *Puma yagouaroundi* in North of Paraná (40X).

Histopathological examination revealed marked parasitic pneumonia, with extensive foci of pulmonary alveolar invasion by embryonated eggs and helminth larvae (Figure 6). Surrounding these foci, lymphohistiocytic infiltration of the parenchyma and pronounced pulmonary edema were observed. The alveoli were obliterated, containing parasite eggs and larvae[19]. Since the histological section was taken from the lung base, an area without major airways, it was not possible to locate additional *Oslerus* sp. individuals, as these parasites are typically associated with the bronchi and bronchioles. The same applies to *Angiostrongylus* sp., which inhabit pulmonary vessels and the heart[8,12].

Figure 6. Section of the Lung of *Puma yagouaroundi* with parasites and embryonated eggs and larvae (20X).



DISCUSSION

The larvae observed in the feces and lungs show similar morphology, which prevents species-level identification based solely on morphological features. Therefore, combined diagnostic methods, including molecular and serological analyses, are recommended for accurate identification[12].

This study identified co-infection by cardiopulmonary parasites, a condition previously reported in studies conducted in Germany, Spain, and Chile[10,11,20]. Co-infection is possible because Metastrongyloidea species may share intermediate hosts and ecological niches[2]. Moreover, these helminths frequently use paratenic

hosts such as amphibians, reptiles, birds, and rodents in their transmission to carnivorous hosts[4].

The histological findings observed are consistent with prior descriptions of *Aelurostrongylus abstrusus* infections, where granulomatous pulmonary inflammation around larvae and adult parasites, along with intrapulmonary hemorrhages, constitute the main pathological features[21]. These findings reinforce the importance of early diagnosis and epidemiological surveillance in wild environments.

CONCLUSION

Co-infection by cardiopulmonary helminths occurs in *Puma yagouaroundi* because the parasites found share the same intermediate and paratenic hosts. Being a predatory animal, felines are easily infected by larvae present in their prey. Thus, their hunting habits allow them to maintain these cardiopulmonary parasites in wild environments. The marked pulmonary inflammatory process caused by parasitic infection can impair breathing and compromise the definitive host's survival.

Additionally, monitoring these infections has epidemiological relevance, since some cardiopulmonary parasites may have zoonotic potential or indicate environmental contamination cycles involving domestic animals and wildlife. Therefore, continuous surveillance, including molecular monitoring of road-killed felines, is essential to better understand parasite circulation, detect emerging pathogens, and support wildlife health and conservation strategies.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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